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THE METALLOGRAPHY OF IRON AND STEEL.

By Henry M. Howe.

By special arrangement with Professor Howe, made at about the time he first entered upon the work of writing his great treatise on alloys which is shortly to appear in book form, and with the co-operation of his publishers, Messrs. Sauveur & Whiting, THE ENGINEERING MAGAZINE presents these papers selected and condensed from the forthcoming volume "Iron, Steel and Other Alloys."

The portions thus taken for advance publication are those which lend themselves most readily to magazine use for an audience vitally interested in the accurate knowledge of materials of construction, and in the elements of the science which gives that knowledge. In this field there have been few more important contributions than the following beautifully clear and explicit definition of the long-debated question "What is Steel?"

For anything more than the outline permitted by the necessary limitations of magazine publication, the student must be referred to the book. Of Professor Howe's foremost authority on the subject it is needless to say a word. It is internationally recognized. It is proper to say that on account of his present absence in travel the final proofs of the article which appears below have not had the advantage of his personal revision.—THE EDITORS.

WHAT are the iron and steel of commerce and industry? Examined under the microscope they prove to be composite or granitic substances, intimate mechanical mixtures or conglomerates of microscopic particles of certain quite distinct, well defined, simple substances, in widely varying proportions. The structure of these conglomerates is of the type shown on page 648, last month. The chief of these substances are,

1.—Pure (or nearly pure) metallic iron called *ferrite*, soft, weak, very ductile, with high electric conductivity, and in general like copper in its qualities, color excepted,

2.—A definite iron carbide, Fe_3C, called *cementite*, which is harder than glass and nearly as brittle, but probably very strong under gradually and axially applied stress.

Take immediately as the most important fact, the most essential part of the skeleton about which the various phenomena are to be grouped, that the great classes of iron and steel of chief value to the engineer and probably to the world at large, are essentially intimate mixtures or conglomerates of these two strikingly different microscopic constituents—ferrite extremely soft and ductile, cementite extremely hard and brittle, the former like copper, the latter like glass. The properties of several of the classes may indeed be influenced, and very profoundly, by thermal and mechanical treatment, and by the presence in certain of them of slag or of graphite; but the fact on which our attention should be concentrated at first is this, that the difference in properties between the different industrial classes of iron and steel is due chiefly to difference in the ratio which the ferrite bears to the cementite.

What has just been said does not apply, it is true, to what is called "hardened steel," which consists not of ferrite and cementite but essentially of austenite, as will be explained shortly; but it does apply to the great industrial classes of wrought iron and of steel such as ship, rivet, fencing-wire, tube, rail and tinplate steel, and indeed all structural steels whether for plates, beams, eye bars, angle irons or any like object.

The steels which are especially soft and ductile, e. g., the rivet and boiler-plate steels, consist chiefly of the soft, ductile, copper-like ferrite, as do those with very high electric conductivity, such as telegraph and telephone wires. In these steels the proportion of cementite may not exceed one per cent of the whole, the rest consisting almost wholly of ferrite.

The harder steels like rail steels, which are called upon to resist abrasion, e. g., the grinding action of the car wheels intensified by the presence of sand between wheel and rail, have a much larger proportion of cementite. About 93 per cent. of their total mass is made up of ferrite and the remaining 7 per cent consists of cementite. This quantity of cementite suffices to increase greatly the resistance to abrasion, while the loss of ductility which it causes, though very marked, is not dangerously great.

Naturally, as the proportion of cementite in steel increases and that of ferrite decreases, the ductility diminishes continuously and the hardness increases continuously; the tensile strength, however, reaches a maximum when the cementite amounts to about 15 per cent of the whole, and the ferrite is about 85 per cent; with further increase of cementite the tensile strength again decreases. These facts are

sketched roughly in Figure 1. The lines in this figure are intended only to give a sort of bird's-eye view of the subject, because, for given constitution, the properties vary very greatly with the treatment which the metal has undergone. Indeed, in case of hardness trustworthy quantitative data are not at hand.

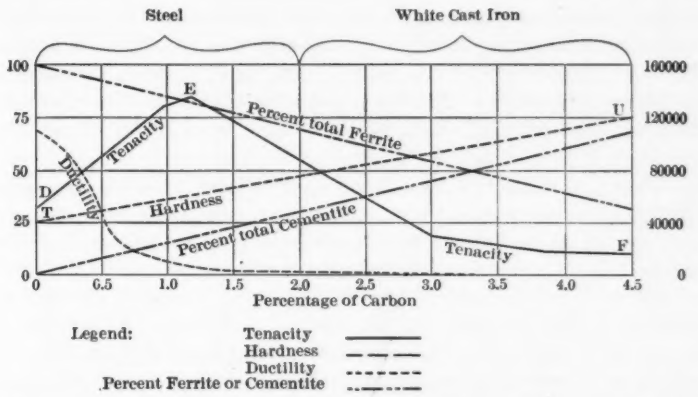


FIG. 1. PHYSICAL PROPERTIES AND ASSUMED MICROSCOPIC CONSTITUTION OF THE PEARLITE SERIES, GRAPHITELESS STEEL SLOWLY COOLED, AND WHITE CAST IRON.

By "Total Ferrite" is meant both that which forms part of the pearlite and that which is in excess of the pearlite, taken jointly. So with the "Total Cementite."

The constitution of steel is not in general reported in the percentages of ferrite and cementite; nor, indeed, are most engineers and metallurgists of today sufficiently familiar with this aspect of the subject to speak of it with confidence. But this is the aspect which the practitioners of the near future must face, and it is also that which enables us to understand the relation between the composition and properties of these different classes of iron and steel. Instead of saying that a certain kind of steel, for instance rail steel, contains so much cementite and so much ferrite, it is customary to report simply the carbon which that cementite represents. For instance, instead of saying that rail steel contains about 7.5 per cent of cementite and nearly 92.5 of ferrite, we habitually and for convenience say that it contains about 0.50 per cent of carbon, which is the quantity represented by the presence of 7.50 per cent of cementite.

Besides these two constituents of prime importance, ferrite and cementite, there are three others of moment; these are graphite, slag, and austenite.

Graphite: Gray Cast Iron.—Graphite is an important constituent of cast iron, especially of gray cast iron, but for our present purpose we may regard it as either absent from steel or, if present, only in unimportant quantities.

Gray cast iron, the only kind of cast iron which can be widely used by engineers, may be regarded as a conglomerate of the second degree; for it consists first of a mechanical mixture of ferrite with cementite quite as steel does; while through this mixture as a matrix there is scattered much free carbon in the form of sheets of graphite as shown on page 809. A weak, foreign body like graphite of course both weakens and embrittles the mass taken as a whole; hence the weakness and brittleness even of gray cast iron.

The graphite itself is pure or very nearly pure carbon in very thin, flexible sheets, which form a more or less continuous skeleton running through the mass of gray cast iron. It appears to be identical with the native mineral graphite (black lead, plumbago).

White cast iron typically would consist of cementite and ferrite quite as structural steel does, but with a much larger proportion of cementite, rising even to 67 per cent (say 4.50 per cent of carbon). Hence the extreme hardness and brittleness of this class of cast iron, so extreme as to exclude it from most engineering uses. But most of the white cast iron of commerce has a constitution intermediate between this extreme type on one hand and gray cast iron on the other; it contains much more cementite than gray cast iron and much less graphite. It is then, like gray cast iron, a conglomerate of the second degree, consisting first of a metallic matrix which is itself a conglomerate of much cementite with a variable proportion of ferrite, and second of a small quantity of graphite interspersed through this matrix.

Slag: Wrought Iron.—Wrought iron consists essentially of a metallic matrix identical with low-carbon steel, in which is mechanically mixed a small quantity of slag, a silicate of iron; this slag is not unimportant, yet it is far less important than the ferrite and cemenite of the matrix.

Austenite: Hardened Steel.—Steel hardened by sudden cooling from a red heat consists essentially of austenite, a solid solution of carbon in iron of varying degrees of concentration. When austenite contains as much as one per cent of carbon it is intensely hard and brittle; and indeed its hardness and brittleness are roughly proportional to the quantity of carbon which it contains. Hence steels for purposes which require extreme hardness, such as files and other tools for cut-

ting metals and even wood, have from about 0.75 to 2.00 per cent of carbon, enough to give the degrees of hardness required for the special purpose, but not enough to cause a prohibitory degree of brittleness; and they are "hardened" by sudden cooling.

Besides the cutting tools, armor plate and projectiles are habitually made of hardened steel, and therefore consist essentially of austenite. Thus the austenitiferous steels are of importance, at least when contrasted with the non-ferrous metals; but the quantity of austenitiferous steel in actual use is but an insignificant fraction of the non-austenitiferous, that which consists essentially of ferrite and cementite.

Heat Treatment.—As has been mentioned in passing, the properties of certain classes of iron and steel are influenced very greatly by thermal treatment. While this appears to act (1) in part by changing the size and arrangement of the microscopic crystalline grains of which the conglomerate mass consists, and probably (2) in part by inducing allotropic changes in the iron proper, yet (3) a very large part of its influence is through shifting the condition of the carbon between the three states of cementite or iron carbide (Fe_3C), austenite or solid solution of carbon in iron, and free carbon or graphite. In view of this latter mode in which heat treatment affects the properties of the metal, it is but natural that its influence should in general be the more pronounced the more carbon the metal contains. Thus wrought iron and the very low-carbon steels containing from 0.06 to 0.10 per cent of carbon are in general but little affected by heat treatment; while the high-carbon steels are influenced most strikingly. Cast iron, too, may be affected very greatly by heat treatment.

Alloy steels, such as nickel, manganese, tungsten, chrome and molybdenum steel, have important specific qualities which collectively are of importance; but their importance is secondary to that of the great classes which have already been outlined.

To recapitulate, the essential distinction between wrought iron and steel is that the former necessarily contains a small quantity of slag, which the latter lacks. The great and striking distinction between steel and cast iron is that the former contains less carbon than the latter; the boundary between them may be put roughly at two per cent of carbon.

Division into Three Great Classes According to Carbon-Content.—Thus divided there are three great classes, which are as follows:

1.—With less than 0.30 per cent of carbon, called *soft* or *low-carbon steel* when free from slag, and *wrought iron* when containing slag; soft, ductile and relatively weak (tensile strength say 50,000 to 80,000

pounds per square inch in case of steel), i. e., weaker than the second class, higher carbon steels, yet far stronger than cast irons, and with relatively little hardening power.

2.—With between 0.30 per cent and 2.00 per cent of carbon, called ***medium*** and ***high-carbon,*** or ***half-hard*** and ***hard steels,*** harder, less ductile, and stronger than the low-carbon steels, more ductile and far stronger than the cast irons, and with marked hardening power. The tensile strength generally lies between say 80,000 and 130,000 pounds per square inch. The hardness and hardening power increase, and the ductility diminishes, as the carbon increases, in each case apparently without limit; while the tensile strength increases with the carbon content till this reaches about 1.00 or 1.20 per cent, and then again decreases,

3.—With more than 2.00 per cent of carbon, called *cast iron,* which is much weaker and much less ductile than classes 1 and 2. Cast iron may be either "white," "gray" or "mottled."

In white cast iron most of the carbon is chemically combined with the iron instead of being in the state of graphite.

Gray cast iron contains much of its carbon in the condition of graphite, so that the cast iron itself is a conglomerate of this free or graphitic carbon mechanically mixed with the remainder or metallic part of the mass, which may be called the "matrix."

Mottled cast iron is intermediate in composition between gray and white cast iron, having part of its carbon free or graphitic, and the rest chemically combined with the iron.

Of these three kinds of cast iron, the gray is by far the softest and least brittle, the white is the hardest and most brittle, while the strongest cast iron is between the extremes of the grayest and the whitest.

Gray cast iron may be as soft as the low-carbon steels, and white cast iron may be as hard as and perhaps harder than any even of the high-carbon steels; but all these cast irons are both weaker and more brittle than either low or high-carbon steel. Thus all cast irons are weak and brittle, but some are very soft and others very hard.

Figure 1 shows in a general way these three important physical properties, the strength, ductility, and hardness of these three classes or iron (for the moment leaving gray and mottled cast iron out of sight), and how these properties are related to the carbon content. The whole may be summed up by saying that as the carbon increases, the hardness increases and the ductility decreases, both without limit; but that the tensile strength reaches a maximum with about 1.00 or 1.20 per cent of carbon, and decreases with farther increase of carbon.

Wrought Iron.—The members of the weld-metal class contain a small quantity (usually from 0.20 to 2.00 per cent) of slag or cinder, (in this case a very basic silicate of iron oxide), because they are made by welding together pasty particles of metal at a very high temperature, in a bath of this slag, without subsequent fusion or other means of expelling it completely. Of this series the only member today of importance is wrought iron, which usually contains only a very little carbon. Its characteristic structure is shown in Figure 3, in which the black streaks are little rods of slag drawn out in the process of rolling or hammering the balls in which the wrought iron is first made into bars or sheets. The remainder of the mass is essentially made up of separate crystals of nearly pure iron or "ferrite," interfering with each other and hence misshapen. The differences in tint are due to differences in the way in which different crystals are acted upon by the nitric acid or other reagent with which the specimen is etched, differences which in turn are due to such causes as difference in orientation, i. e., in the direction of the axes and cleavage of the different crystals.

Wrought iron differs from the low-carbon steels, e. g., from those used for making rivets, fencing wire, and the sheet iron used for conversion into tin plate by coating with tin, essentially in containing this small quantity of slag. Such steel is practically free from slag, for the simple reason that it is cast in a very fluid state into ingots or other castings, and that this fluidity enables any slag present to separate by rising to the surface by gravity. The carbon content of wrought iron and of such steel is substantially the same, and hence their properties are closely alike, save in so far as those of wrough iron are affected by the presence of this small quantity of slag. As such steel is actually made, it usually contains rather more manganese but less phosphorus than most wrought iron; this gives a slight further difference in properties between most wrought iron and most of such steel; but this difference is neither necessary nor essential.

Definitions.—In considering the foregoing classification we note that there are two distinct bases for the name steel. The "weld-steels" are called steel because they differ from wrought iron in containing a considerable quantity of carbon, and from cast iron in being malleable; the low-carbon steels are called steel because they differ from wrought iron in being slagless, and from cast iron in being malleable. This confusing nomenclature must be endured, at least for the present.

However, the matter is not so bad as it looks at first. The weld steels are unimportant. The three important classes are wrought iron,

steel, and cast iron. Wrought iron is readily and almost sharply distinguished from the others by its containing slag. And, fortunately, there is one criterion which we may adopt for discriminating between all the various classes of steel on one hand and those of cast iron on the other, a criterion which we may apply to all future varieties of iron when we seek to decide whether they ought to be called steel or cast iron. This criterion is malleableness in at least some one range of temperature; we may adopt it because such malleableness is probably the only important specific property which all steels of today have, and all cast irons of today lack, if we except the special product known as "malleable cast iron," which really stands in a class by itself, through its genesis, constitution and properties. In the following scheme of definitions this criterion is used.

Wrought iron, slag-bearing, malleable iron, which does not harden materially when suddenly cooled.

Steel, iron which is malleable at least in some one range of temperature, and also is either (*a*) cast into an initially malleable mass; or (*b*) is capable of hardening by sudden cooling; or (*c*) is both so cast and so capable of hardening. (Tungsten steel and certain classes of manganese steel are malleable only when red-hot.)

Cast iron, iron containing so much carbon or its equivalent as not to be malleable at any temperature.

Malleable cast iron, iron which when first made is cast in the condition of cast iron, and is made malleable by subsequent treatment without fusion.

Alloy steels and *cast irons* are those which owe their properties chiefly to the presence of an element (or elements) other than carbon.

Ingot iron, slagless steel containing less than 0.30 per cent of carbon.

Ingot steel, slagless steel containing more than 0.30 per cent of carbon.

Weld iron, the same as wrought iron. The term is little used.

Weld steel, slag-bearing varieties of iron malleable at some temperatures, and containing more than 0.30 per cent of carbon. It differs from wrought iron only in containing more carbon.

These definitions cover not all conceivable but simply the present important classes of iron. Should others later become important, their nomenclature may then be determined.

Source of the Confusion in Our Nomenclature.—It may be of interest to expose in passing the way in which much of the confusion in our present nomenclature has arisen, both to show the student from

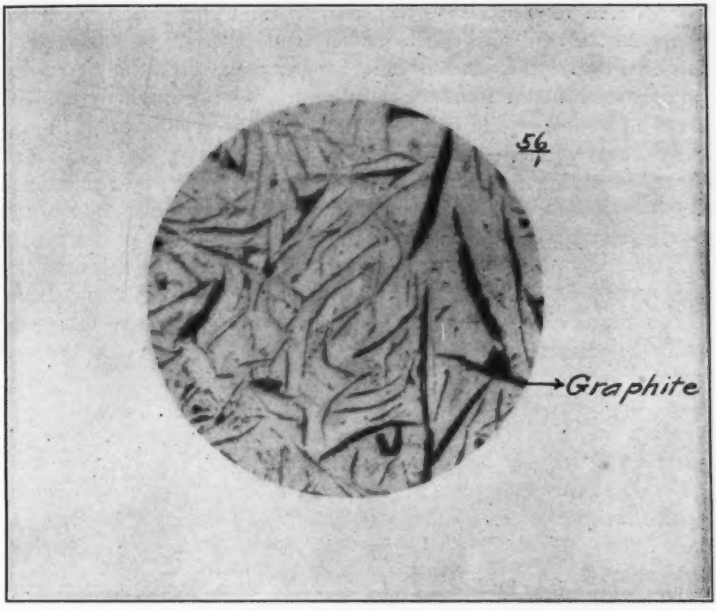


FIG. 2. GRAY CAST IRON, CAST IN SAND.

what motives these systems may arise, and also to give warning of the sort of trouble which is likely to arise in case we give names based, not on essential and definitive properties, but on accidental ones which are not definitive, no matter how important they may be.

Until about 1860 there were only three important classes of iron—wrought iron, steel and cast iron. The essential characteristic of wrought iron was its nearly complete freedom from carbon; that of steel its moderate carbon content (say between 0.30 and 2 per cent), which, though great enought to confer the property of being rendered very hard by sudden cooling, yet was not so great as to make the metal brittle when cooled slowly; while that of cast iron was a carbon content so high as to make the metal brittle whether cooled quickly or slowly. This classification was based on carbon content, or on the properties which it gave. Wrought iron, and certain classes of steel which then were important, necessarily contained much slag or "cinder," because they were made by welding together pasty particles of metal in a bath of slag, without subsequent fusion. But the best class of steel, crucible steel, was freed from slag by fusion in crucibles; hence its name, "cast steel."

Between 1860 and 1870 the Bessemer and open-hearth processes introduced a new class of iron, today called "mild" or "low-carbon steel," which lacked the essential property of steel, the hardening power, yet differed from the existing forms of wrought iron in its freedom from slag, and from cast iron in being very malleable. Logically it was wrought iron, the essence of which was, that it was (1) "iron" as distinguished from steel, and (2) malleable, i. e., capable of being "wrought." This name did not please those interested in the new product, because existing wrought iron was a low-priced material. The only justifiable alternative would have been to assign a wholly new name to the wholly new product; but as steel was associated in the public mind with superiority, it appeared more attractive to appropriate its valuable name. This was done with the excuse that the new product resembled one class of steel—cast steel—in being free from slag; and, after a period of protest, all acquiesced in calling the new product "steel," which is now its firmly established name. The old varieties of wrought iron, steel, cast steel, and cast iron preserve their old names; the new class is called steel by main force. As a result, certain varieties, such as blister steel, are called "steel" solely because they have the hardening power, and others, such as low-carbon steel, solely because they are free from slag.

The Microscopic Constituents of Iron and Steel.—The great advance which has taken place in our knowledge of the constitution of steel and the other varieties of iron has shown that they resemble very closely the igneous and metamorphic rocks, i. e., exactly those which, like the different varieties of iron, have formed from the cooling of molten or at least pasty masses. Just as a granite on close examination is seen to consist of an aggregation of crystalline fragments of mica, quartz, and feldspar, each of which is a definite chemical compound, with definite crystalline form and definite physical properties in general, so the microscope shows us that a given piece of steel or iron usually consists of extremely minute crystalline particles of two or more substances, each of which is a definite entity, with definite chemical composition and definite physical properties.

But besides the granitic type, certain varieties of iron seem to represent the obsidian type. In this, as in aqueous solutions, the ratios in which the different chemical substances, the silica, lime, etc., exist are not fixed or definite; they vary from case to case, not *per saltum*, as between definite chemical compounds, but by infinitesimal gradations. The different substances present appear to be dissolved, as it were, in each other in a sort of solid solution which has the indefiniteness of

composition, the incapacity of being resolved by any magnification of the microscope, and the feeble chemical attraction between the different components, characteristic of a solution.

The schistose structure of rock masses, their columnar or basaltic structure arranged in columns perpendicular to the cooling surface, their "vugs" or cavities lined with specimens of free crystals, their segregation, etc., are reproduced in a most interesting way in metallic masses.

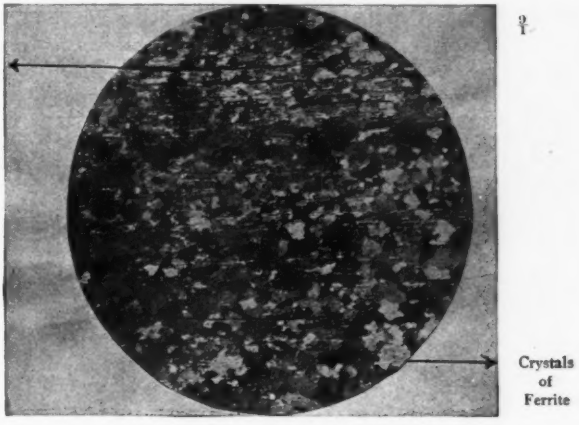


FIG. 3. WROUGHT IRON FORGED. LONGITUDINAL SECTION.

With the exception of the rods of slag shown in black, the whole of the mass consists of crystals of ferrite interfering with each other and therefore irregular in shape.

Of these different microscopic entities which constitute the different varieties of iron, only the following here need consideration:

1.—Ferrite, the microscopic particles of nearly and perhaps perfectly pure metallic iron. It is magnetic, very soft and ductile, but relatively weak, with a tensile strength of about 45,000 pounds per square inch. It is of the isometric system. It always forms a very important part of slowly cooled iron and steel in general (excepting the alloy classes).

When much slag is present, as in wrought iron, and is drawn out into fibers by rolling, the mass as a whole is thereby given a certain kind of pseudo-fibrousness; but even here the metallic or ferrite quasi-fibers usually consist of an aggregation of grains, each of which is equiaxed. (See Figure 3.)

2.—Cementite, a definite carbide of iron, Fe_3C, containing 6.67 per cent of carbon, very brittle, harder than hardened steel, scratching glass and feldspar but not quartz, (H = 6), and magnetic. The carbon in slowly cooled steel is chiefly or wholly present as cementite, of which there is therefore $(56 \times 3 + 12) \div 12 = 15$ per cent for each per cent of carbon present. In slowly cooled cast iron, too, it is probable that all or nearly all of the combined carbon as distinguished from the graphite is present as cementite. It is one of the constituents of pearlite, and is an important constituent of slowly cooled iron and steel in general, of course excepting the varieties which are nearly free from carbon. Its carbon is often spoken of as *cement carbon*, and is the *carbide-carbon* of Ledebur.

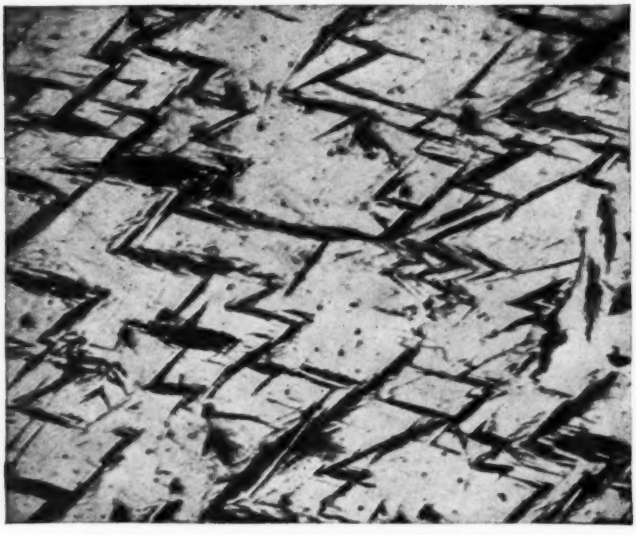


FIG. 4. CEMENTITE IN AUSTENITE. CEMENTED CARBON STEEL.

Carbon about 1.50 per cent. Quenched at 1050° C. in ice-water.

Figure 4 shows cementite associated with austenite in a suddenly cooled high-carbon steel. The black zigzag constituent is the cementite, the white ground mass is the austenite. While this is not the habitual shape in which cementite is found in the varieties of iron with which we are most familiar, it is nevertheless probably idiomorphic, if we may judge from the conditions under which it came into existence.

3.—Pearlite, consisting of interstratified plates of ferrite and cementite, in the ratio of about six parts by weight of the former to one of the latter, as inferred from its containing about 0.90 per cent of carbon. The exact composition of pearlite is still in dispute, and I adopt this number of 0.90 per cent only provisionally and for the purpose of fixing our ideas.

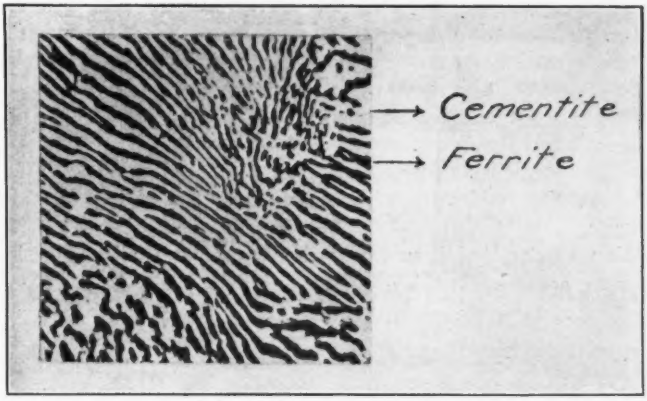


FIG. 5. PEARLITE, STEEL (CARBON ABOUT 1 PER CENT.) FORGED AND ANNEALED AT 800° C.

Slowly cooled steel consists essentially of a conglomerate of this pearlite plus the excess-substance, which is ferrite if the carbon-content is below 0.90 per cent, but is cementite if it is above 0.90 per cent. Paraphrasing Osmond, steel may be called "æolic," "hyper-æolic" or "hypo-æolic," according to whether it contains just 0.90 per cent of carbon, or more than that or less.

Slowly cooled cast iron probably consists essentially of a conglomerate (1) of pearlite with its accompanying excess of either ferrite or cementite according to whether the combined carbon is less or greater than 0.90 per cent, and (2) of graphite.

Figure 5 shows the structure of pearlite. The black stripes are the ferrite, which, although itself white, here looks black owing to the conditions of preparing and illuminating the specimen.

4.—Austenite, the characteristic and chief constituent of suddenly cooled, i. e., "hardened" steel, is a hard, brittle mass, with a needle-like structure, and is a solid solution of carbon in iron, the proportion of carbon varying from nothing up to about two per cent. Its hardness and brittleness increase with its carbon content.

Martensite, troostite and sorbite are transition forms between austenite on one hand, and ferrite and cemenite on the other, probably containing all three of these substances, but in varying proportions. They need not be considered in the present elementary discussion.

Summary.—To recapitulate, the chief constituents of the iron-carbon compounds, the steels and cast irons, are:

1.—In the slowly cooled state of both steel and cast iron, *pearlite,* a conglomerate of (2) the soft, weak, ductile *ferrite,* and (3) the hard brittle *cementite,* in the ratio of 6:1, together with whatever excess of ferrite or cementite is present over and above this ratio.

4.—Also in the slowly cooled state of cast iron, *graphite,* a non-metallic and as it were foreign body,

5.—In the suddenly cooled state of both steel and cast iron, *austenite.*

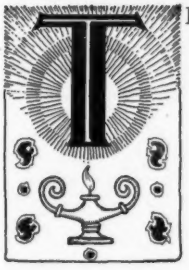
We may classify all our iron-carbon compounds, all our steel and cast irons, according to this grouping.

GREAT ELECTRIC INSTALLATIONS OF ITALY.

By Enrico Bignami.

THE ROME-TIVOLI POWER PLANT AND TRANSMISSION.

The installation described by Signor Bignami is interesting as a combination of steam and water power in the same service—the hydraulic source having been brought in to supplement the boiler plant when modern conditions made larger demands for power, and modern developments made it economical to transmit it electrically over greater distances. It is a sort of concrete instance of one of the important tendencies of the times in mechanical and electrical engineering. And it is interesting further because the instance is supplied by a country which is poor in engineering industries, and must call upon foreign manufacturers for the necessary equipment. In this aspect, it epitomises one of the most important commercial developments of the times.—THE EDITORS.



HE fame of the falls of Tivoli runs far back into history, and even in the middle ages their power was utilised in small manufacturing operations. It was natural, therefore, that Tivoli should have been the site of one of the first hydro-electric stations; and this plant—on the Gaulard and Gibbs system—imperfect as it may have been, is worthy of recognition for its historic interest from the point of view of the distribution of alternating currents by means of transformers in parallel. Here is the site for a monument to the memory of Emile Gaulard, for here was the first installation for the distant transmission of electric energy by his system, from which have developed the systems now in use, and upon which as a foundation also were built the profound and admirable studies of Galileo Ferraris.

The present Tivoli plant was started in 1892 by the Società Anglo-Romana, which has a monopoly of gas and electric lighting until 1928. The original installation was replaced later by four groups of 3,300 kilowatts each, and enlarged and completed now by the addition of three more units of the same size, making a total of 23,100 kilowatts. Turbines and dynamos were supplied by Ganz & Co., of Budapest. Each group is made up of a triphase generator of 3,300 kilowatts at 10,000 volts, direct-coupled to the shaft of its corresponding turbine.

On account of the existing monophase distributing network, and

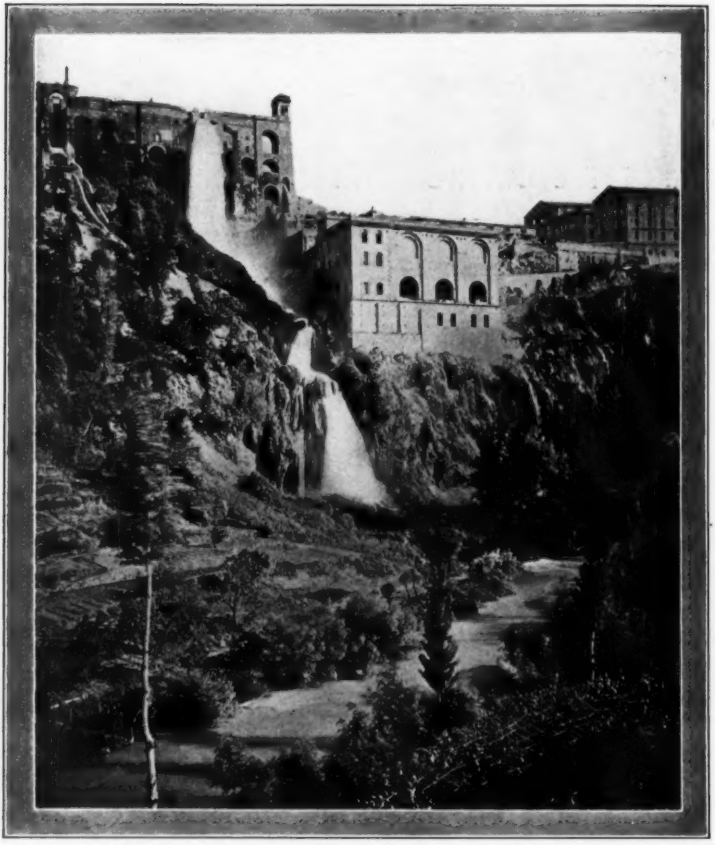


FIG. I. THE CENTRAL STATION AT TIVOLI.

also of the fact that the business done will not yet admit of a regular triphase service, the dynamos have been designed so that they can also generate monophase current and in so doing use all the available power of the turbines.

Each generator has an inductor which is mounted on the main shaft, the latter resting in two bearings and carrying the exciting machine at one end and the flywheel at the other. Surrounding the inductor is the fixed armature, built up of laminated sheet iron. As the generators are direct-coupled to the turbines, they had to be constructed so that if they should rotate at twice their normal speed, owing

to derangement of the turbines or to any other cause, they would not be injured. (Figure 13.)

The armature frame is of cast iron, in four symmetrical parts, bolted together, and forms a solid casing so designed as to resist all the stresses to which it may be subjected. The internal diameter of the armature is 4.02 metres; the total weight of the generator is 76,000 kilogrammes, the inductor alone weighing 25,000 kilogrammes.

Each exciter, as already mentioned, is mounted on one end of a generator shaft. It has a cast-iron frame and six poles, and a drum armature with copper-rod winding. The exciters are shunt-wound. Their main current is led directly to the rotating field of the generator, the regulation being effected by means of resistances inserted in the shunt circuit.

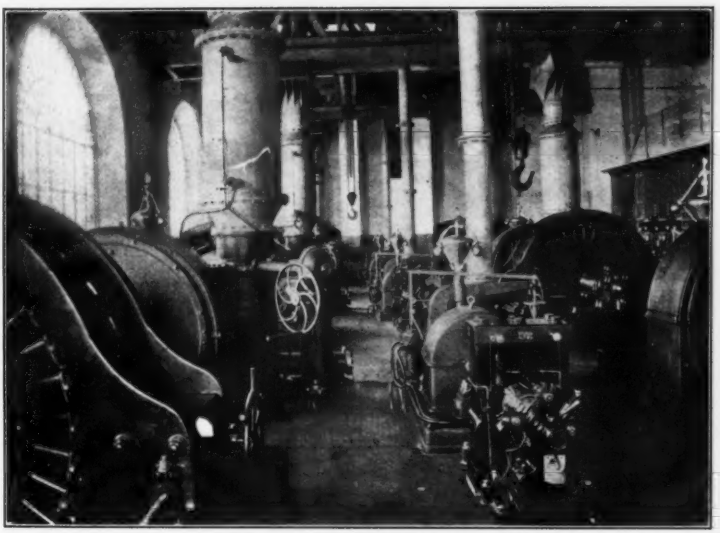


FIG. 2. THE ORIGINAL INSTALLATION AT TIVOLI.

In order to facilitate the erection of the machinery, an electric crane was installed.

On the switchboard, each generating unit has its particular section. The high-tension circuits can be broken by means of high-tension switches, and pass through fuse wires to the bus bars which connect all the generators.

The seven groups represent today, reserves included, an output of 23,100 kilowatts, and the Tivoli plant is therefore adequate not only

to the present needs of Rome but also to the estimated increase for years to come.

The 10,000-volt current generated at the station is brought to Rome by two aerial conductors 27 kilometres long (Figure 6). A large transformer station at Porta Pia (Figure 7) reduces the voltage in accordance with the several uses to which the power is applied—private consumption, public arc lighting, and the city tramway service.

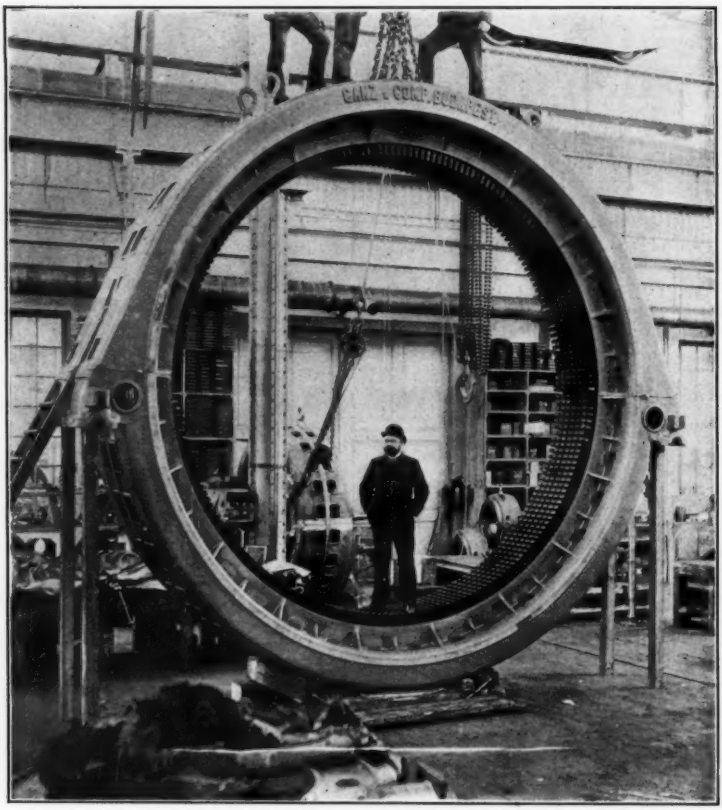


FIG. 3. ARMATURE RING OF A 3,500-KILOWATT ALTERNATOR.

The primary current is therefore distributed to three separate groups of transformers. (Figure 4). One of these reduces the current to 2,000 volts for the private and domestic service—interior lighting and motor applications—which is fed by four concentric cables from the Porta

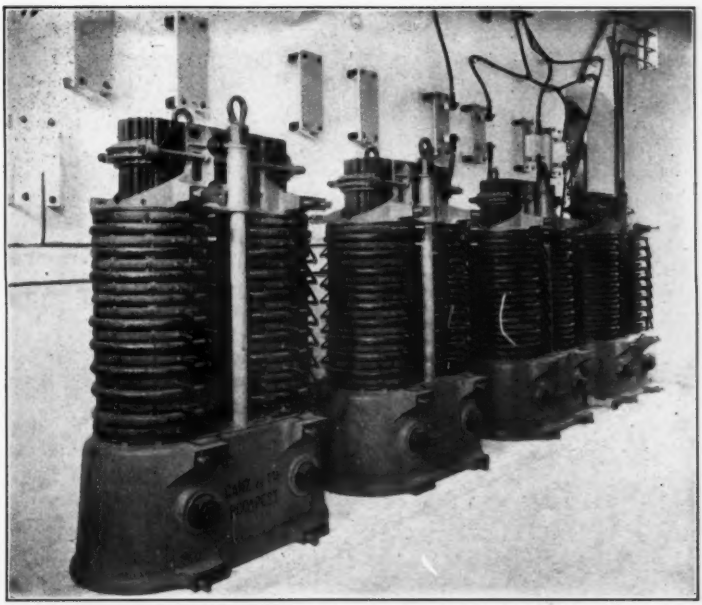


FIG. 4. MONOPHASE TRANSFORMERS AT PORTA PIA.

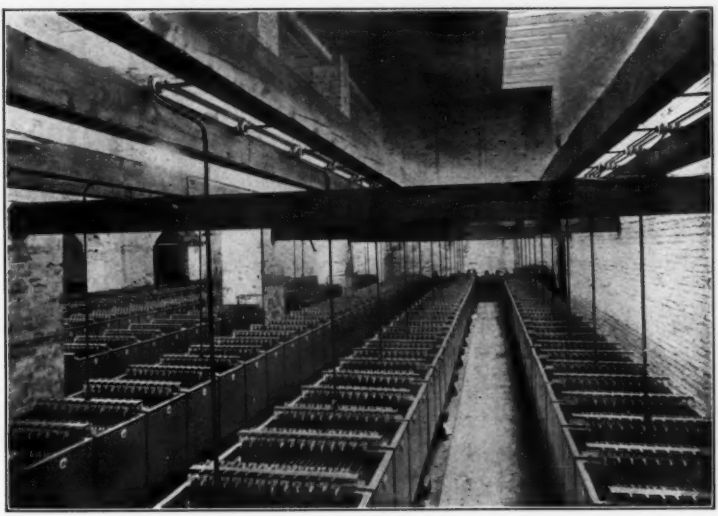


FIG. 5. ACCUMULATORS AT THE PORTA PIA STATION.

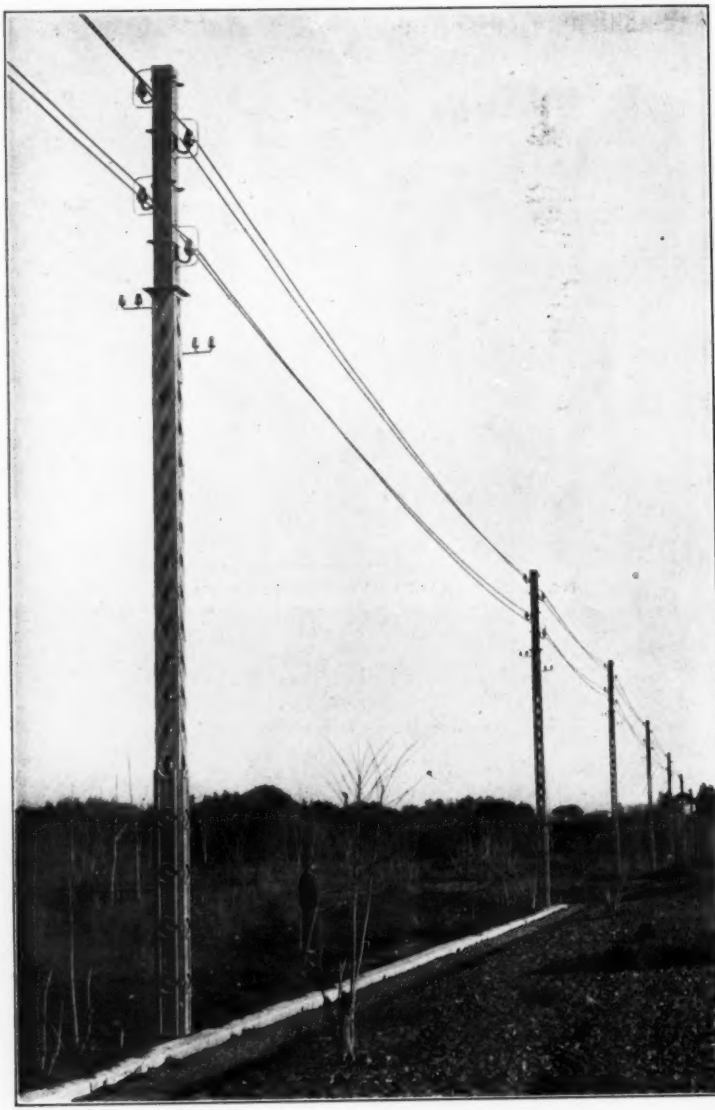


FIG. 6. THE HIGH TENSION LINE AND POLES.

Pia station. The second group also gives a secondary tension of 2,000 volts, but supplies only the system of underground cables connected with the public arc lighting. There are six circuits, each with a maximum of fifty lamps in series, for the illumination of the streets and public places of Rome.

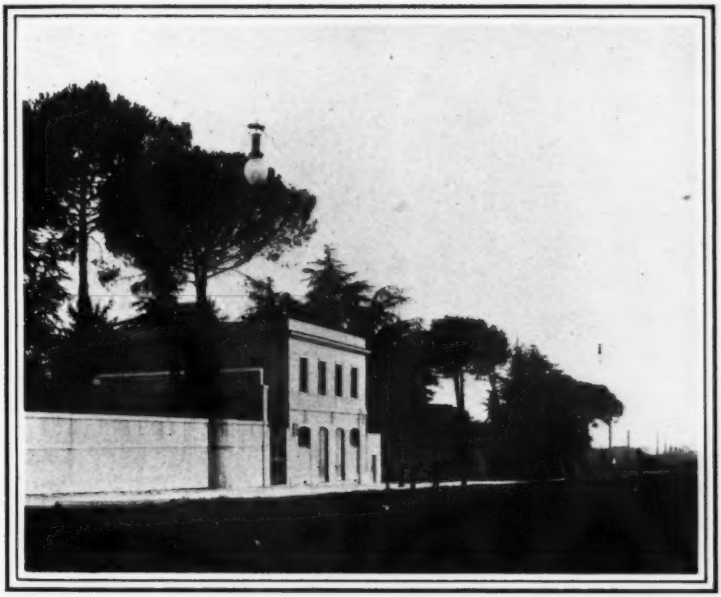


FIG. 7. THE PORTA PIA TRANSFORMER STATION.

A third portion of the primary current from the Tivoli station is transformed and converted by rotaries to direct current at 500 volts for the city tramway service, a large accumulator battery working in connection with the rotaries to equalise the distribution of the direct current. The fourth and last fraction of the power supply goes to four rotaries of special construction, which convert the alternating current into direct current for the tramway system, without the intervention of any static transformer.

A special cable connects the transformer station of Porta Pia with the steam-driven power station of Cerchi, permitting the secondary distributing network of Cerchi to be supplied from Tivoli, and also, in case of need, the Porta Pia circuits to be supplied from the steam power plant at Cerchi. The total output of the latter station is 2,700

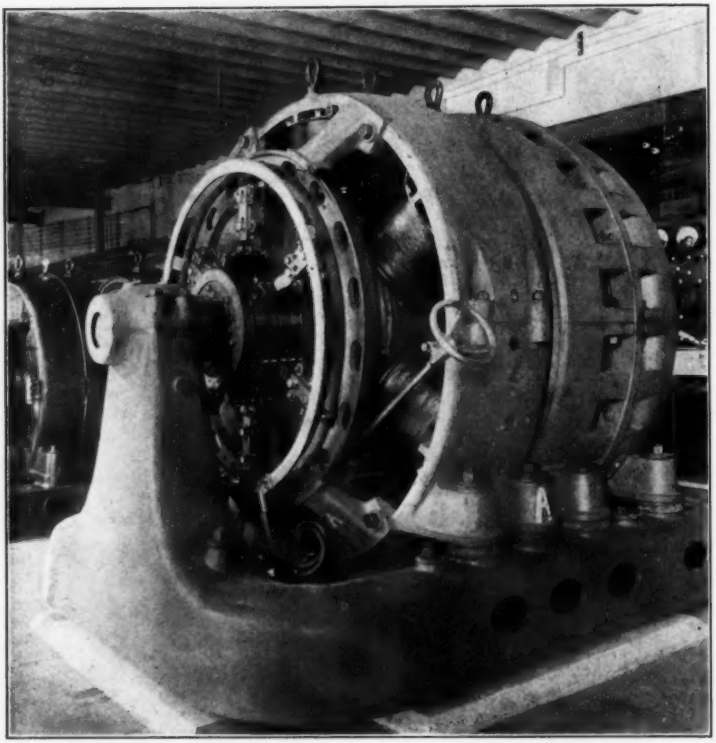


FIG. 8. ONE OF THE ROTARY CONVERTERS IN THE PORTA PIA STATION.

horse power, and the primary circuits (2,000 volts) intersect those of the Tivoli system at many points in the city. At several of these places are switches by which sections of the one system may be connected to one of the stations of the other. The total current output naturally varies greatly with the season, in so large a distributing system, and this arrangement gives entire statisfaction in apportioning the load properly between the two stations.

The Cerchi installation is very important historically, for its plans were prepared in 1885, at a period when alternating current had not been employed except in small isolated plants, and not as yet for distribution over a relatively extended network. The station was finished in 1889, following entirely the lines of the orignal plans.

The electric machinery of this station comprises two alternators of

150 horse power each, and four units of 600 horse power each. There are four continuous-current exciters, direct-coupled to their steam engines. The original portion of the plant, as it was completed in 1886, contained only the two smaller units. It is of interest to observe that all the alternators are of the one type, known as "Type A" of Ganz & Co. It should speak well of the merits of the construction that so many years had rendered necessary only insignificant changes from the original form. These machines are particularly adapted to high-tension service.

The regular development of the electric lighting of Rome began in 1886 and this plant is probably the first high-tension alternating-current station in the world with underground distributing mains and transformers in parallel. It worked with so favourable results that soon a considerable enlargement was determined upon. In the second half of 1887 two of the large alternators driven by 600-horse-power engines were put in, and a little later the other two. As the alternators may run in parallel or independently, as special conditions may dictate, four rheostats of the Blathy type are installed to insure constant tension. Each one may be connected to any one of the alternators.

The conduits proceeding from the Cerchi station carry four feeders, which are supplied (as conditions of distribution may require)

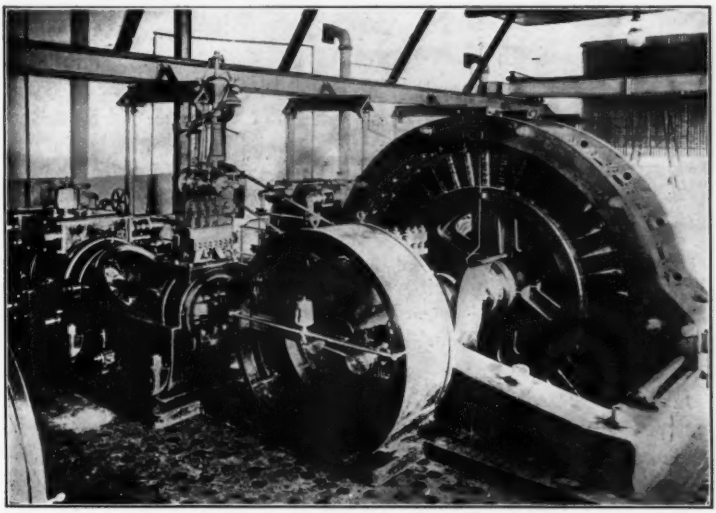


FIG. 9. THE CERCHI POWER HOUSE.

separately or in parallel by the corresponding alternators. Service conditions often necessitate some change in the particular machines to be kept in operation—perhaps the substitution of one generator for another—without interruption of the service. To this end Mr. Blathy has devised a special switch which permits any one of the six generators to be thrown instantly into the supply of any one of the four feeders. The construction of the switch is highly ingenious and it forms one of the characteristic features of the Cerchi plant.

The transmission line which, as already mentioned, connects the Tivoli station with the Porta Pia transformers, may be connected with any part of the Cerchi circuits by a special switch which connects it with the switchboard. In this case the corresponding steam-driven dynamo is cut out from the bus bars.

In spite of the repeated enlargements of the Cerchi station, it remains inadequate to the constantly rising demands for electric current, and it is on this account that the Tivoli water power was called in to aid.

The course of the transmission was practically dictated by the antecedent location of the conduit for water, connecting Tivoli with Rome across the Campagna Romana. The electric and hydraulic lines parallel one another for almost the entire distance. Leaving the central station, the electric transmission line descends toward the River Anio, (which falls about 165 feet lower than the level of the station), crosses the river, climbs a hill, traverses a great olive plantation, and meets the Marcia hydraulic canal. This it follows to a point near Mount Mammolo, thence diverging by a shorter line to Rome. (Figure 10). At different points on its course the transmission line crosses the railways from Rome to Solmona, from Rome to Orte, and the State telegraph lines. At all these crossing points safety devices are installed to prevent accident from the breakage and fall of a high-tension wire. The Anglo-Romano gas company has secured a strip 9 feet in width the whole length of the right of way, to provide for the erection of another pole line for the future enlargement of the undertaking. Half way to Rome is a small building called the "*capannacce.*" (Figure 11). It is not only a shelter for the line patrol, but a store house for material and for the repair tools and apparatus. Here also electric measurements may be made, the nearest pole being provided with sectional insulators interrupting the continuous line from Tivoli to Rome. Lightning arresters are also provided. On most parts of the line the poles are of metal, lattice form, as shown in Figure 12. The telegraph and telephone wires are fixed on the metal part of the poles, phosphor

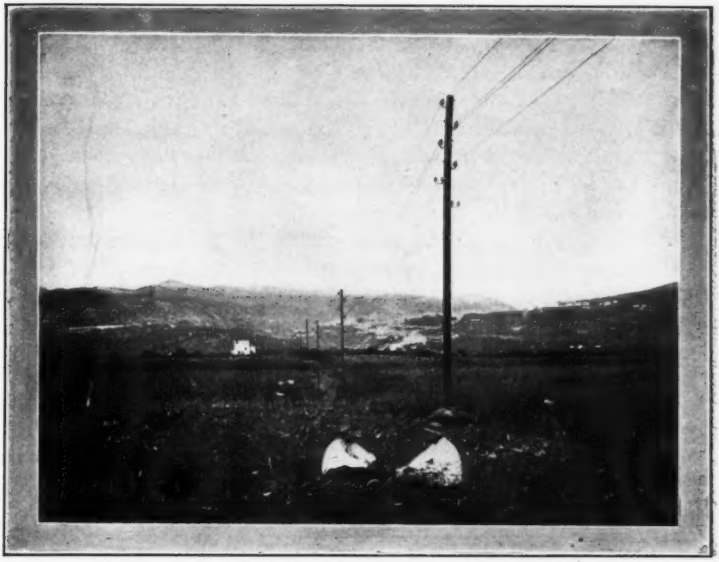


FIG. 10. THE TRANSMISSION LINE ON THE CAMPAGNA ROMANA.

bronze being used both for direct and return circuit. To avoid induction, the wires are alternated every ten poles—that is, every 1,500 feet. The absolute potenial of the telephone line is quite high, so that one touching it, if in contact also with the ground or the pole, would receive a very disagreeable shock. Thus the telegraph and telephone wires, placed below the four high-tension wires, act as sentinels against the danger of coming in contact with the high-tension transmission. There are four small telephone stations along the line, so that the watchmen can communicate promptly with the head stations.

The line leads, as already stated, to the transformer station of Porta Pia, shown in Figure 7. This station contains two parts, one containing the transformers, the other containing the switchboards, control apparatus, and automatic rheostats. The transformers are show in Figure 4. They are of the latest Ganz type, and their iron cores are in two parts. Each part is built up of iron sheets in the form of an E, held together by circular end plates with a diameter great enough to allow the transformer to be rolled on the ground, thus facilitating their handling. One of the end plates carries the primary and secondary terminals. Each conductor has its own fuse, which is

mounted on the wall of the transformer room, and can be replaced even during the regular operation of the plant.

The transformers are divided into two groups, one for the private service distribution, the other for the public lighting. The street arc lamps are set at distances of 130 to 160 feet apart, and elevated from 25 to 30 feet above the ground. Each lamp takes 14 amperes at about 35 volts. They are all of the Zypernowsky type, burning 14 hours without renewal of the carbons.

Four separate concentric cables supply the private consumers of light and power, the distribution being made, as already said, under a pressure of 2,000 volts. For the 102-volt incandescent lamps and 51-volt arc lamps in parallel used by consumers on these circuits, low-

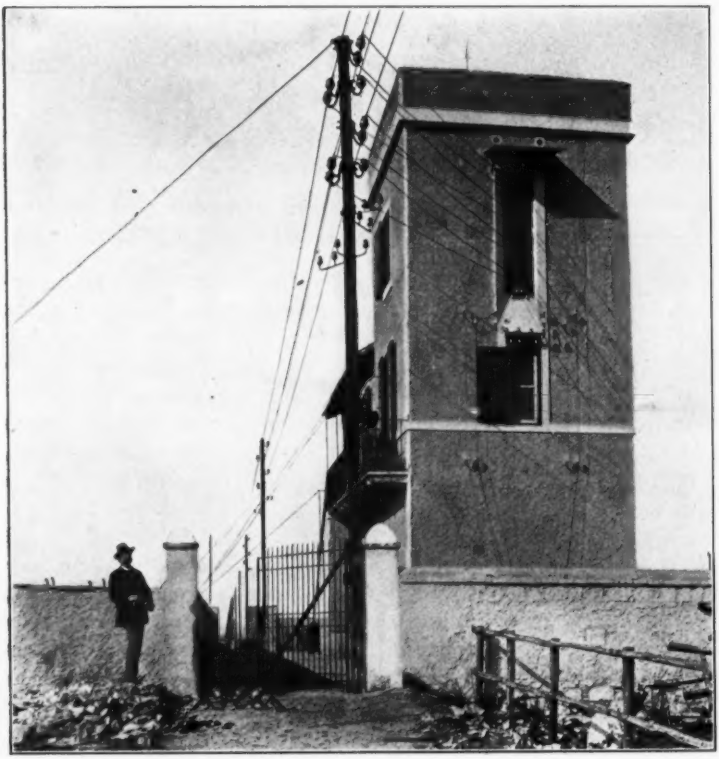


FIG. 11. THE "CAPANNACCE"—MEASURING AND LINE-PATROL STATION ON THE LINE FROM TIVOLI TO ROME.

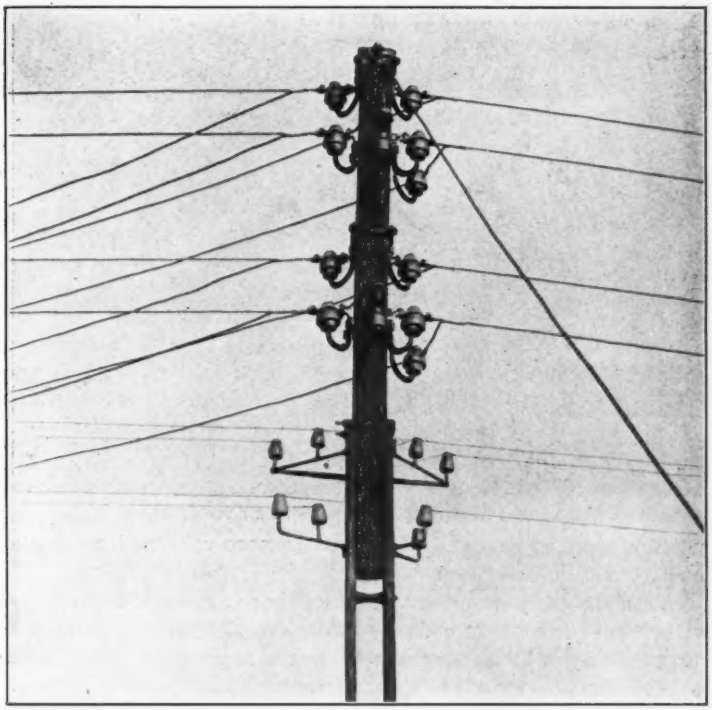


FIG. 12. ONE OF THE POLES, SHOWING TRANSMISSION CABLES, TELEGRAPH AND TELEPHONE WIRES.

tension current is provided by transformers distributed along the length of the cables. These are similar in construction to those in the main station at Porta Pia, a constant ratio of transformation of 1 to 18 being maintained throughout the system.

The secondary distribution in alternating-current systems is usually effected either by a high-tension primary with individual transformers, or else by a network of low-tension circuits supplied by groups of transformers disposed in sub-stations at convenient distances. After thorough trial, extending over several months, Professor Mengarini arrived at the conclusion that the greatest advantage lay with the method involving the installation of a number of secondary sub-stations, each with a network wholly separate and distinct from the others. This might be regarded as an intermediate between the individual-transformer and the low-tension-secondary systems. Each sub-

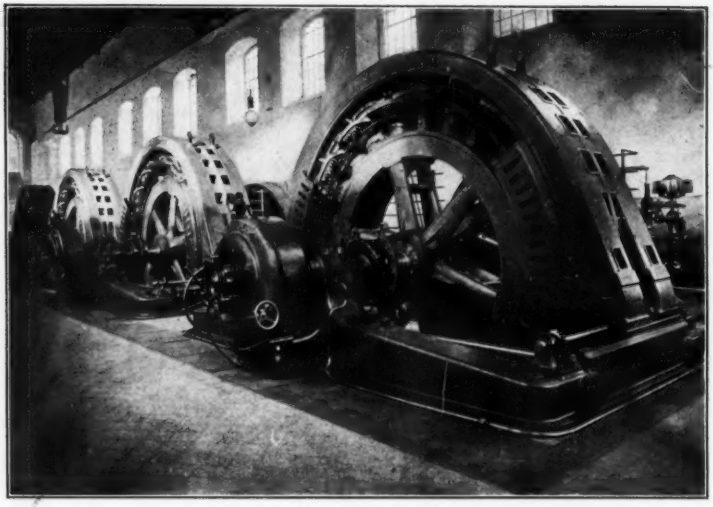


FIG. 13. 3,300-KILOWATT ALTERNATORS IN THE NEW TIVOLI POWER STATION.

station is supplied with primary current at 2,000 volts, and supplies a small three-wire sub-system with 102 volts between the wires.

When the company undertook to supply power for the tramways of the city—some 36 kilometres—a considerable enlargement of the Porta Pia station became necessary. Twelve new transformers (1 to 10) were installed especially for the tramway service, and in addition two large rooms were built for the rotary converters, and two for the accumulator batteries.

The Società Anglo-Romana, which is now the concessionaire of the tramways also, had on its systems on December 31, 1902:

148,318 lamps of all powers, corresponding to 147,002 lamps of 16 candle power.

605 transformers, of which 554 were the property of the company.

2,853 meters.

1,500 kilowatts rented to 252 subscribers for power. Other small motors, especially fans, are in use by patrons of the lighting service.

1,134 arc lamps, of which 260 are assigned to the public lighting of Rome, still for the most part effected by gas.

3,000 kilowatts for traction purposes on 36 kilometres of tramway.

Comparison with the figures for 1901 shows that the increase in the use of electric light continues, and that there is a very marked advance in the use of electric power.

THE MODERN RACING YACHT AN ENGINEERING PROPOSITION.

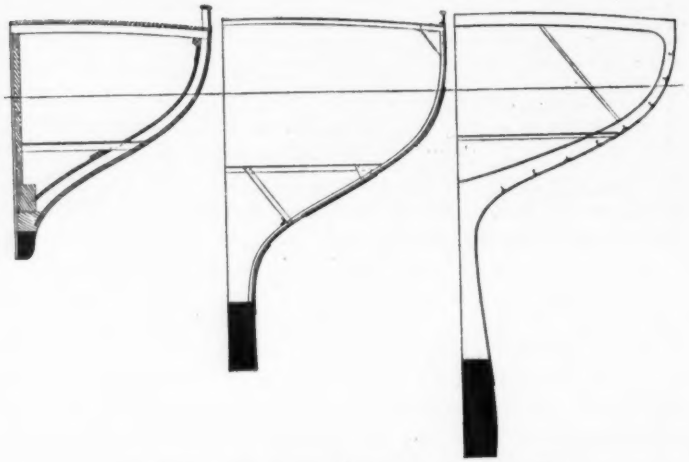
By W. P. Stephens.

The keynote of the conception which has made the modern racing yacht an engineering proposition is expressed in Mr. Stephens' statement that "speed is merely a question of horse power per ton of displacement." This reduces the whole thing to a refined problem in marine powering and bridge building. The rapid progress under this realization, and the tendency of exact scientific methods to lead all designers to a single type, are most interestingly told in the following article.—THE EDITORS.

IN the great game of yacht sailing just being played outside Sandy Hook, there is one feature above all others which appeals to every one of the many thousand spectators, striking with equal force the practical yachtsman and most casual looker-on. The towering spars and enormous area of canvas on each contestant are so far in excess of anything previously seen over any hull of similar size as to challenge the attention of the greenest landsman. The result of these great sail plans is simply power in excess, out of all normal and reasonable relation to the elements of the hull, and it is only through such excess of power that a comparatively small gain in actual speed is possible. There is nothing more difficult to measure than the true speed of a large sailing yacht, as she may race for an entire season without once realizing that peculiar combination of conditions which will put her at her best; in default of reliable figures we may assume that the speed of the first of the great class of 90-foot Cup defenders, Puritan, was about 12 knots, and that the modern representatives of the class are capable at the utmost of 15 knots. To attain this increase of 25 per cent., certainly a liberal one, the length on the waterline has been increased from 81 feet to 90 feet, 11 per cent.; the displacement has been increased from 105 tons to something under 150 tons, or about 40 per cent.; while the sail area has risen from 7,300 square feet to 16,000 square feet, or an increase of nearly 120 per cent. Incidentally, while the cost of the modern Cup racers is known only to owners, designers, and builders, it is safe to say that the wooden Puritan, today in use as a cruising schooner, cost less than one-tenth of the bronze Reliance whose value in a very few years will be only that of scrap metal.

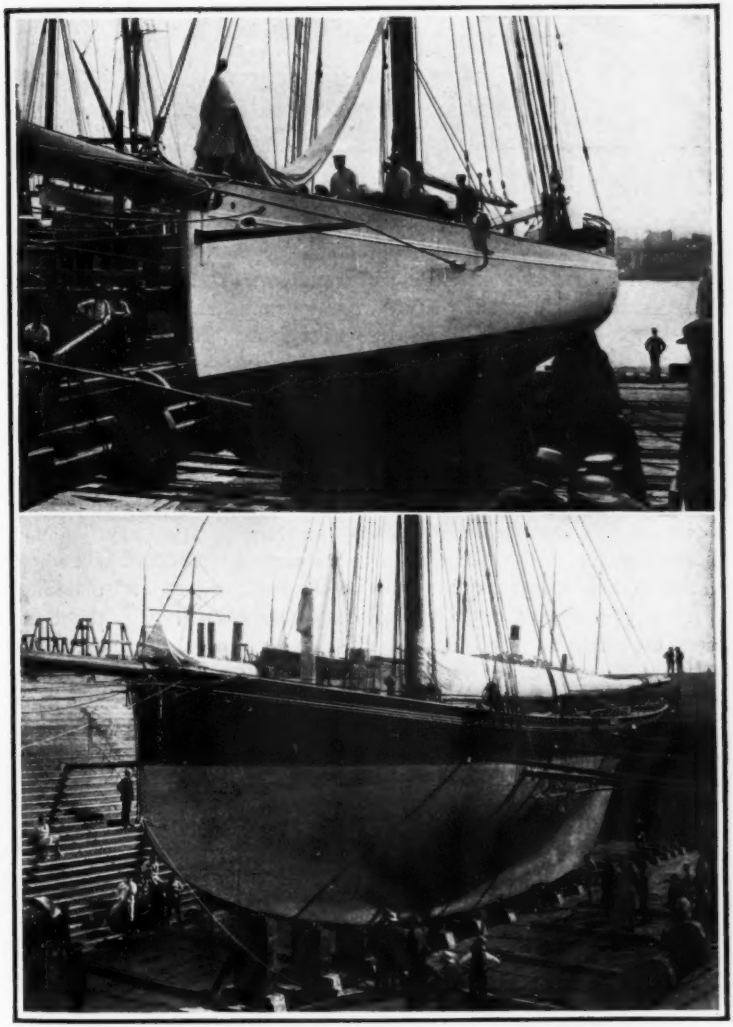
While George Steers, the modeller of the first Cup winner, the schooner America, in 1851, was a man of remarkable ability and orig-

inality, a leader among the old-time shipwrights for which New York was once famous, the designing and building of yachts was until a comparatively recent period wholly in the hands of men who were merely ship-builders. The crude method of working from the cut model, the heavy construction, and the clumsy rigging, were but slight refinements on the ordinary practice in commercial craft. The fight of the professional yacht designer, planning everything in advance over his drafting table, against the rule-o'thumb builder working by guess in rough imitation of a cut model, had really been won before



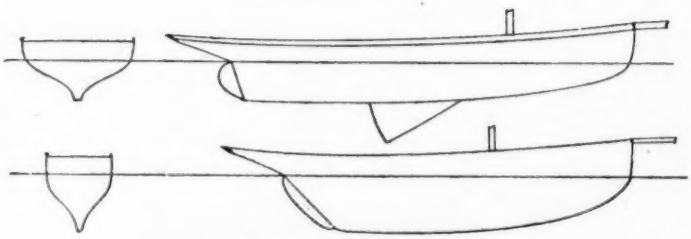
CHANGES IN CUP-YACHT CONSTRUCTION SINCE 1885.
On the left is the centerboard cup defender of 1885; center, the steel yacht of 1885-93; right, the modern 90-foot cup defender.

the building of Puritan; but she and her contemporary, the steel cutter Priscilla, were the first yachts actually designed according to modern methods for the defense of the Cup. In working out deliberately, long in advance of all work of construction, the lines, construction drawings, and details, the arrangement and sail plan, with the accompanying calculations of displacement, positions of centres, stability, and other important attributes, the yacht designer of that day was on a far higher plane than his predecessor, the practical builder; but, at the same time, the work of the two was closely identical in its general scope. In neither the design nor the construction was there any necessity for special skill in engineering as distinct from the usual methods of naval design and construction.



PURITAN AND GENESTA—THE DEFENDER AND CHALLENGER OF 1885.

The relative depth will be better appreciated by taking the figure of one of the bystanders as a measuring unit.



I. THE CUP CONTESTANTS OF 1885.

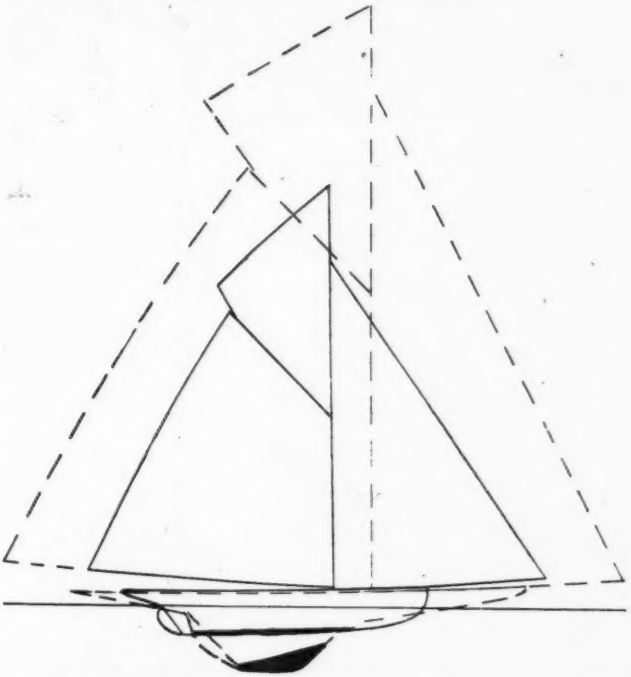
Genesta, keel cutter, challenger; Puritan, centerboard cutter, defender.

Such a form as that of Puritan could be made amply strong by a very simple construction, merely wooden frames and planking with a few simple longitudinal members such as clamps, shelves, bilge stringers, and ceiling, and either oak or metal floors across the keel. Though heavy in the extreme according to all modern standards, this construction, while both cheap and durable, was far lighter than anything previously known. While the hull itself was subjected to only moderate strains from the sea, it was amply strong to carry without special strengthening the local strains due to the rig and concentrated at such points as the mast step, the shrouds, the runner plates, traveller, and bobstay plates. All of these strains were carried by the hull as a whole through such elementary members as the keel, frames, and planking, without even the aid of the ordinary steel diagonal straps. Above the deck the generous scantling of spars and rigging gave ample strength with the conventional arrangement of members; and, if the weight was excessive, all shared alike in the same handicap.

While British designers had before this begun to cut the weight of construction, under the strong stimulus afforded by the possibility of putting into a deep lead keel every ounce saved from rigging and topsides, neither party had yet been moved to lessen the displacement, and American designers gave little or no attention to the question of weight, contenting themselves with researches in the proportions of breadth and depth, and in the refinement of forms of comparatively large displacement.

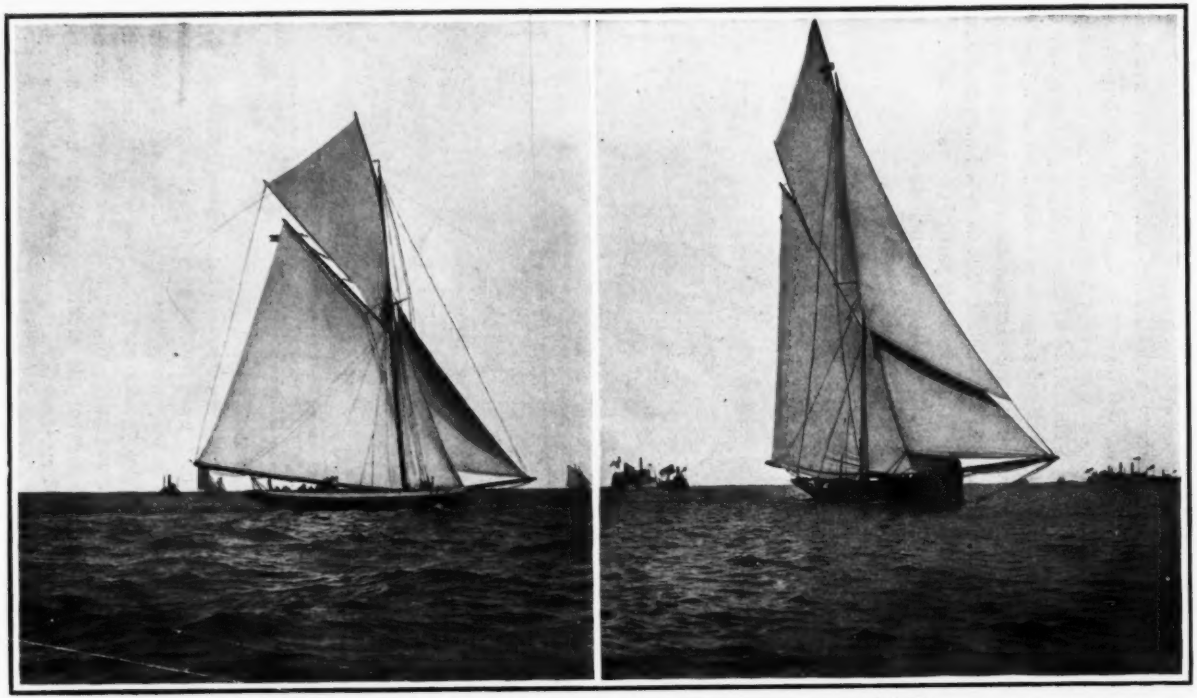
The first move in the direction of light construction came from the builders of fast launches and torpedo boats, the Herreshoffs in particular, who early in the eighties awoke to the realization of the truth that, after a certain perfection of form is attained, further increase of speed is merely a question of horse power per ton of displacement. In accordance with this theory a bold cut was made in the scantling of steam launches; single frames of small size, bent from steamed oak,

being substituted for the heavy double frames sawn from more or less straight-grained plank; two thicknesses of light wood, white pine or cedar, carefully fitted, laid in white lead and fastened to the frames with brass screws, being used instead of heavy single planking bolted or even treenailed to the big frames and then wedged off with tightly driven caulking. The work of the Herreshoffs for many years was confined almost exclusively to steam craft such as speed launches, fast cruising yachts, and torpedo boats, no small part of their success being due to their bold cutting of the weight of construction.



HULL AND SAIL PLAN OF PURITAN COMPARED WITH MODERN 90-FOOTER.

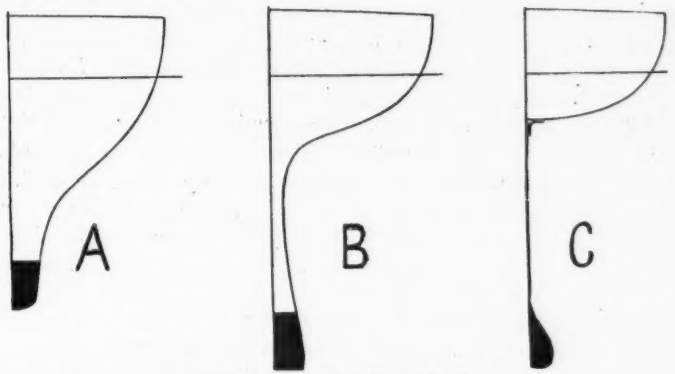
The years 1889 and 1890 were notable ones in yachting; the cessation of the Cup contests in 1887 was followed by a remarkable revival in the smaller classes, the 70-foot and the 51-foot both feeling its effects in a measure. It was in the two still smaller classes, however, the 40-foot and the 30-foot, that the yachts were most numerous and the sport most keen and exciting. The wonderful work of the little Fife cutter Minerva in defeating every American yacht of her class in



PURITAN. GENESTA.

THE CUP CONTESTANTS OF 1885 UNDER SAIL.

1889 and halving the honors with Gossoon, a new Burgess boat specially designed to beat her, in the following year, served to concentrate the attention of both racing yachtsmen and designers on these small classes. When in the fall of 1890, by an unaccountable and unreasonable whim, the 40-foot class was dropped for a new one of 46 feet waterline, Mr. N. G. Herreshoff determined to venture anew in the domain of match sailing and early in the spring of 1891 he launched his famous Gloriana.



MODERN TYPES OF RACING YACHTS.
A, cutter; B, semi-fin-keel; C, fin-keel.

With the same dimensions and displacement as the other boats of the class, Gloriana embodied some marked departures in form, these experiments now being accepted as principles of designing; but no small part of her superiority was due to her improved construction, small light frames reinforced by metal straps and braces, and a double skin that was strong, tight, and gave an almost seamless surface. In the rig, too, were seen many experiments, some since discarded and others elaborated into important improvements. Following closely on Gloriana, launched toward the end of the same summer, came a craft in every way more radical, the famous fin-keel Dilemma.

The fin-keel is an evolution rather than an invention; at a time when ample displacement was still considered an advantage, between 1885 and 1890, the successive work of a British designer, Arthur E. Payne, shows a regular progression of more and more hollow S sections giving a reduction of displacement while both breadth and depth of lead keel were retained to give power, and the fin-keel was rapidly approaching in this way; but to Mr. Herreshoff is due the credit for the first work in the United States, and that in one bold determined step.

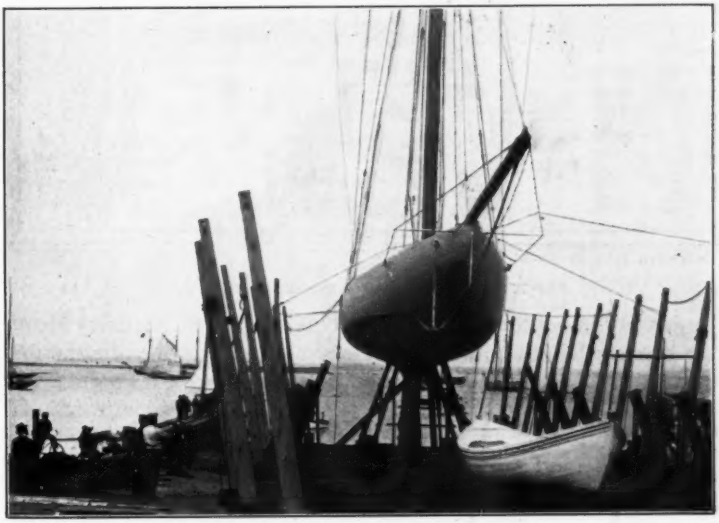
The egg was broken, and those who had not yet recovered from the shock of Gloriana were for the moment stunned by the new discovery, the news of the little boat's performances being widely heralded. The evil lessons of light displacement and light construction were soon learned by both yachtsmen and designers and the whole course of yachting was diverted into a new channel.

While the fin-keel soon dominated the smaller classes, the first of the Herreshoff 90-footers, Navahoe, Colonia, and Vigilant, built in 1893, were fairly normal in displacement, form, and construction; though Vigilant was plated with bronze, the first use of this more costly metal, the scantling and the general arrangement of parts did not depart widely from the accepted practice of the day in steel yachts; and the rigs, though very large, were strongly proportioned. With the next Cup defender, built in 1895, Defender by name, Mr. Herreshoff made a radical departure. In model the yacht was a semi-fin-keel, the displacement being reduced, the midship section cut to an extreme wine-glass form, and the lead keel dropped to a great depth—the extreme draft being 19 feet against only 14 feet in Colonia, but two years older. With this altered form was a radical cutting of weights, the scantling being reduced to the lowest limit of safety in all parts, while an extra effort was made to obtain lightness at the sacrifice of durability if not of strength by the liberal use of aluminum plating instead of steel for the outer skin and even the waterways, partner plates, and deck beams. This lightening of the hull proper permitted an increase in the weight of the lead bulb, and this in turn was dropped much lower than ever before, the net result being an increase in stability which permitted a far larger sail plan than on Vigilant or Colonia. The success of Defender over two yachts of widely different type, the trial yacht Vigilant of 14-feet draft of keel and with a centerboard weighing 3½ tons and dropping to a depth of 7 feet, and Valkyrie III with a draft of 20 feet to the bottom of her lead keel, demonstrated the superiority of her type and established certain principles now generally accepted by all who design for the Cup races.

In form this type is best described as the semi-fin-keel, the hull proper resembling a great canoe, of limited depth, and narrow in comparison to the great length due to the excessive overhangs forward and aft. The displacement is reduced to a minimum, the block coefficient of the modern Cup racers being about 0.12 as compared with 0.25 in Puritan. The general form is marked by the convexity of all its lines, there being no hollows, and the fore-and-aft lines, in particular the diagonals, being remarkably long and of fair circular sweep. The

power to carry the enormous sail plan is derived mainly from the lead bulb, weighing at least 90 tons, which is suspended at a depth of a dozen feet below the hull. In the smaller classes the "fin" is merely a plate of steel or bronze, attached by means of two angle irons to the keel of the yacht, the lead, in two halves, being bolted to the lower edge of the plate. This construction is inadequate in a 90-footer, and the fin is formed by carrying down the frames and plating to meet the lead, the result being a compromise best described as the semi-fin-keel.

With the acceptance by designers of a certain finality in type, dimensions, and form of hull, there is also a general recognition of two facts:—that displacement must be reduced to a minimum; and that, on any given displacement, a reduction of weight above the top of the fin, and in particular above the waterline, gives added weight in the keel and an increase of sail-carrying power. The problem which the designer has to solve is very largely one in modern engineering, with its expert knowledge of materials; he has a floating body of something under 150-tons displacement which from its dimensions can hardly be of other than good form; beneath this he must suspend by an absolutely rigid connection a weight of at least 90 long tons; above it he must rear a light but immensely strong structure of spars and canvas.



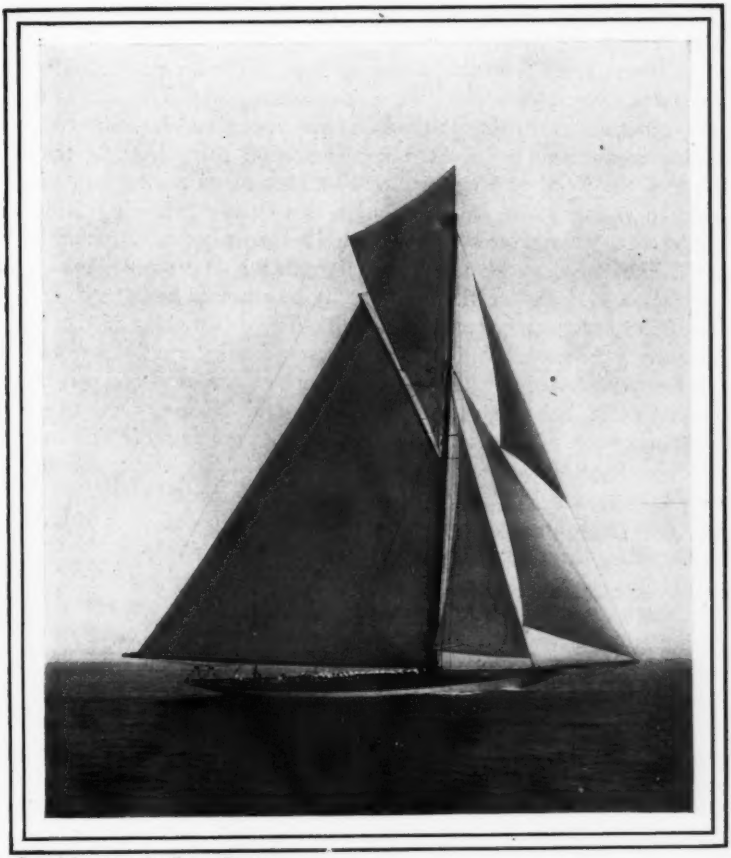
RELIANCE ON THE WAYS, SHOWING UNDERBODY AND FIN KEEL.

Copyright, 1903, by James Burton.

RELIANCE, THE CUP DEFENDER OF 1903.

In this work no specific factor of safety is recognized, but every member is worked down to the smallest possible limit which will stand the strain for a brief series of trial and final races.

The old-time yacht builder gave little thought to his materials; white oak furnished him with keel, frames, and part of the planking, with yellow pine for the remainder and for clamps and bilge stringers and ceiling; these being the standard woods. The modern designer is called on at the outset to consider the relative values of metals—nickel steel with its high average of strength for weight, but with a surface



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SHAMROCK III., THE CUP CHALLENGER OF 1903.

that is necessarily rough in salt water, bronze, with its almost perfect surface but added weight, aluminum, light, unreliable, and short of life; all present certain advantages and disadvantages. How closely these balance is shown by the fact that the two designers concerned this year, both men of wide experience, have chosen in one case steel and in the other bronze for the plating of the hull; while one deck is of sheet steel and the other of thin aluminum plates. This same question of the strength and weight of material comes up in the selection of steel for some spars and wood for others, of steel wire or manilla rope for the

different parts of the running rigging, and in the testing of all kinds and weights of canvas.

Entirely apart from the matter of lines, the hull construction is a special study very closely allied to bridge engineering. The hulls of the old yachts, even including Puritan and Mayflower, may be compared to a plain box of solid boards, deriving its strength solely from the thickness of the wood and the size and number of nails; the hull of a modern racing yacht, small or large, is virtually a floating bridge, subjected to a far greater variety of strains than any fixed structure on land, and deriving the necessary strength within narrow limits of weight solely from the the high quality of material and the complicated and elaborate system of trussing. There is nothing in modern yachting more remarkable than the capture of an international trophy, the Seawanhaka cup, in 1896, by two amateur designers and builders located on an isolated lake, and the successful defense of the cup in eight successive matches; but both of these men are by profession engineers—bridge builders—and it is the successful application of their professional knowledge to yacht designing and practical match sailing which has put them at the very top among modern designers of small craft, professional as well as amateur.

The elements of success in modern match sailing are many and varied but among the more important are the dimensions and the form of hull, the construction, the making of the sails, the tuning up of the yacht by trial races, the generalship which plans the consecutive manœuvres of each race, the personal skill of the helmsman, and the quick work of mates and crew in handling sails. Years of close competition on both sides of the Atlantic have brought British and American yachtsmen into close touch on most of these points; the differences of model are almost superficial; any new details in the rig of one yacht are quickly appropriated by her rival; no one can say to a certainty that American sails are better than the British or the reverse. The skipper of the successful Columbia, winner in two Cup contests, was born in Scotland and obtained his first knowledge of yacht racing in British waters, while the skipper of the third Shamrock has learned much by three previous experiences on the American side. If any one factor can claim the first place in the continued retention of the America Cup by American yachtsmen, it is the daring and skill in engineering by which the designer of Defender, and Columbia—and, we Americans hope, Reliance as well—has produced in each case a lighter hull, and in particular a larger, lighter, and more effective rig than the respective challengers.

THE TOOLS AND METHODS OF A SWISS LOCOMOTIVE WORKS.

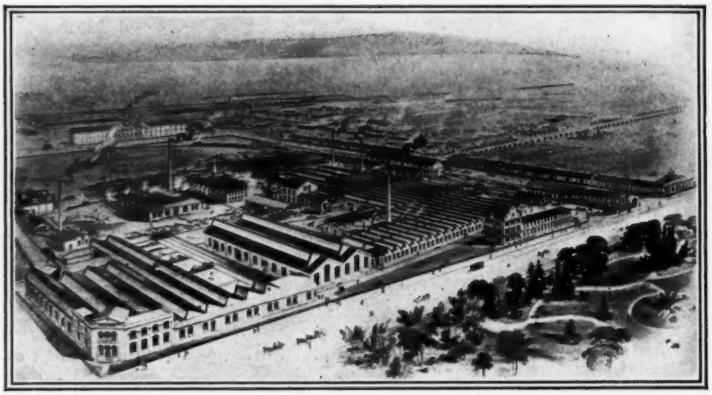
By Charles R. King.

The works described by Mr. King, like those which form the subject of Signor Bignami's article, represent to a considerable extent the transplantation of engineering practice to a foreign soil. In this case, the practice is that embodied in the American, British, and German tools with which the shops are largely equipped, and its fusion with that which is more strictly local forms an interesting study.—The Editors.

N Switzerland the construction of locomotives has become so much a national industry that at present one single works there has now the monopoly of all orders for the Swiss railways to the exclusion of foreign competitors. The Swiss locomotive is designed with much care, made and built with precision, and the Federal and private railway companies of Switzerland can therefore afford, with a little patriotism thrown in, to keep their orders at home. This is in striking contrast with the custom of a neighbouring country, Italy, where the two principal railways are owned although not exploited by the State, yet locomotives are tendered for by foreign makers without any restriction and not infrequently an order will go *fuori* when the home builders, who are only favoured to the extent of 5 per cent, have been underbidden by merely a few *lire*. Yet it would be a very rash person, outside of an Italian locomotive department, that would dare say that an Italian locomotive was less good in its boiler work or mechanism than a German or Swiss; and there are at least four or five very good locomotive-builders in Italy, while mechanical ability and initiative are not wanting with their engineers.

Winterthur, the site of the Swiss locomotive works mentioned, is really a centre for mechanical industries, with Sulzer Brothers for steam engines and Rieter & Co. for electric generators and hydraulic plant.

Leaving Paris and passing via Basel and then, by a considerable detour, via bleak Zürich, Winterthur—also bleak—is found to be an out-of-the-way provincial town—with still more "provincial"-looking but unpicturesque inhabitants. In such a spot one is led to ask whether the locality was selected by design or at the chance of hazard, and the latter surmise is the one confirmed. For here there is no water power, coal has to be imported principally from Westphalia and costs at pres-

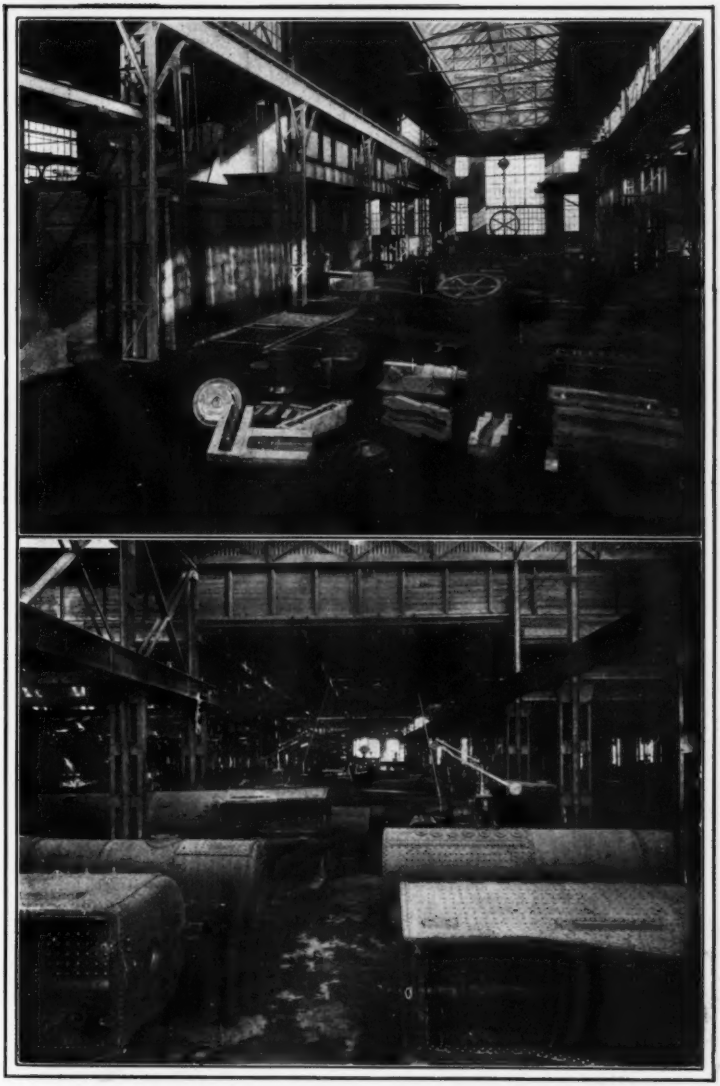


THE SWISS LOCOMOTIVE AND MACHINE WORKS, WINTERTHUR.

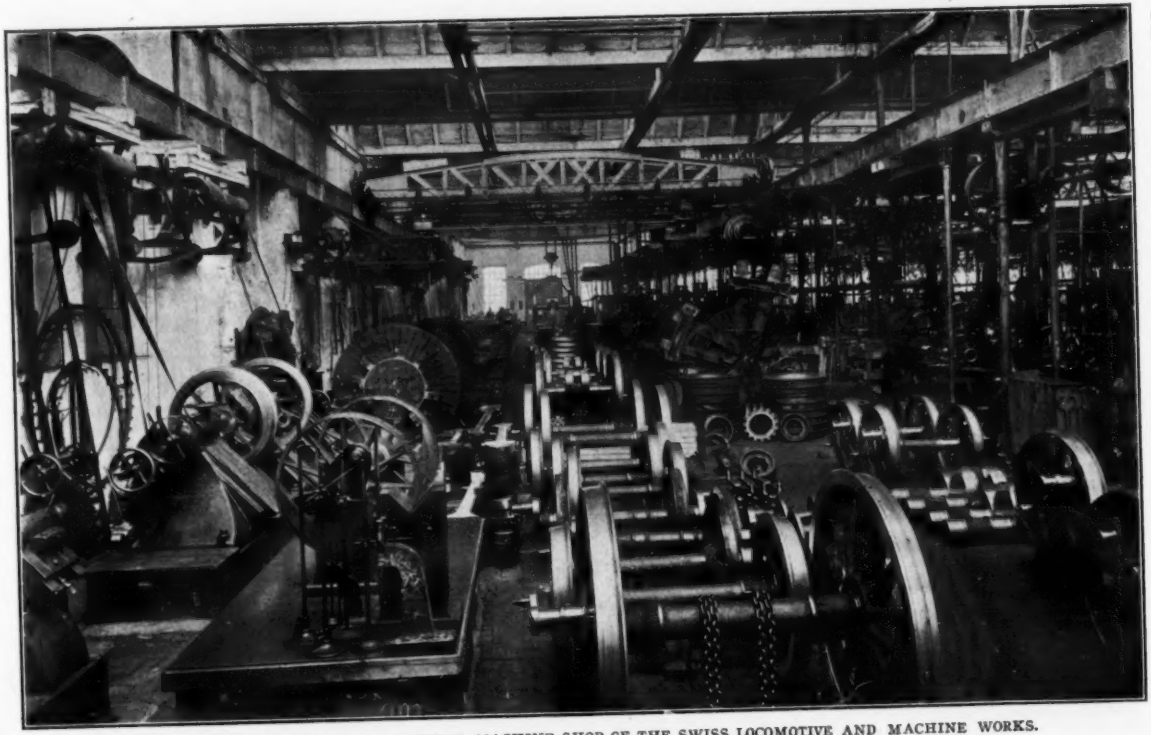
ent about 36 francs for the tonne (2220 lbs.); iron comes from German iron works, and the natives are not at all suggestive of that natural smartness desirable in machinists; however, despite these unfavouring circumstances, the steam-engine and locomotive works at Winterthur have both a high reputation for fine work.

The locomotive works are situated clear away from the town and about half a mile from the Nord-Ost railroad line to which they are connected by a special track. The buildings are laid out with great orderliness, but excepting that they are modern and with vertical roof lights call for no special remark. The ground on which they are situated has a superficial extent of 88,874 square metres so that there is plenty of space available for future developments. The number of workmen employed is 1,200 and the present annual productive capacity of locomotives is stated to be 100. Taking the twenty-eight years preceding the end of the century the average number of normal-gauge locomotives constructed during that time amounted to 21 per year, or if narrow-gauge and tramway locomotives are added, 45 per year, exclusive of extra boilers and also of the gas engines (200 of all sizes), gas-making plant, and small steam engines and boilers which form an important addition to the output from the Winterthur machine works, to which Italy has so far been the best foreign client for small locomotives.

The motive power available for the shops, but not necessarily developed for daily needs, amounts to about 900 horse power. This is composed variously as follows: one steam engine of 150 horse power



FOUNDRY AND MACHINE SHOP OF THE "SCHWEIZERISCHE LOKOMOTIV & MASCHINENFABRIK," WINTERTHUR.



WHEEL SHOP AND PART OF THE GENERAL MACHINE SHOP OF THE SWISS LOCOMOTIVE AND MACHINE WORKS.

and another of 80 horse power in the older shops; while in the new shops and foundry there is a 220-horse-power gas motor and another of 120 horse power (both of the Winterthur system) each running a triphase Rieter generator of 390 volts for force transmission. There is also in the new shops one gas motor of 50 horse power and one gas motor of 30 horse power. For the electric cranes there is another of 50 horse power running a Brown triphase generator. For illumination by electric light two gas motors of 100 horse power are available. The plant for gas making upon the Dowson system is now equal to 700 horse power, and the company finds it more economical, in the end, to obtain energy from coal by the extraction of its gas than by its combustion—4½ to 5 cubic metres of steam-blown gasogene being produced from 1 kilogramme of coal.

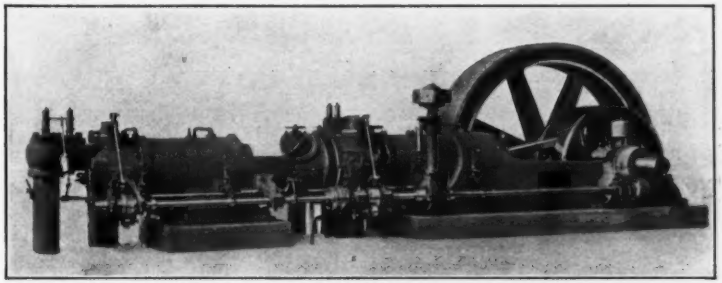
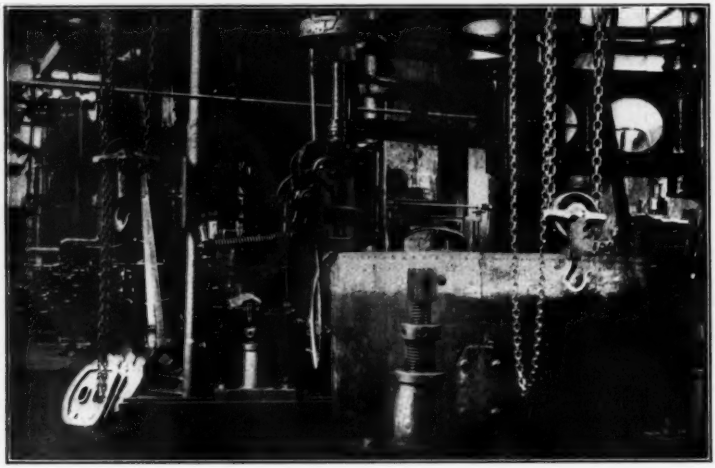


FIG. I. WINTERTHUR GAS ENGINE OF 220 HORSE POWER, DRIVING ELECTRO-GENERATOR FOR TRANSMISSION OF POWER BY TRIPHASE CURRENT TO SHOP MOTORS.

Boiler Shop.—The boilers customarily made at Winterthur often present divergencies from the usual types in the matter of the firebox casings or shells, the back plate in certain locomotives being turned round so that its flanges project outwards, the object being to enable wide-top fireboxes to be put in the shell from the back and then to rivet the boiler head entirely from the outside, instead of leaving one of the side sheets open for the insertion through the bottom side, as usual; and many of these Swiss boilers, having deep fireboxes and made for six-coupled locomotives, are given a sharp backward rake at the front of the firebox in order to allow of the axles being set as far back as possible without raising the boiler centre or cutting into the ash pan.* The flanged plates and the sheets for the boiler construction are generally obtained from Krupp's Essen works and have an

* Quite recently, October 1902, this arrangement was abandoned and the boiler axis raised very considerably, the new locomotives being for the Jura-Simplon line and ultimately destined for service on the Simplon Tunnel route to Italy.

ultimate tensile strength of from 36 to 42 kilogrammes per square millimetre and 25 per cent. elongation on a test length of 20 centimetres. With these parts for the boiler work the installation for plate working is of little importance; but, then, hydraulic flanging-presses are not common in Continental shops and in Italy some makers still do the whole of this angle work by hand in preference to making expensive dies or to paying exorbitant duties upon imported worked materials. The staying of the firebox shell and the front tube plate present no novel features, but in one locomotive boiler under construction (Norwegian) a very unusual arrangement was noticed for staying the back plate to the sides of the firebox shell in the space above the firebox crown by means of a vertical row of short palm stays. When the firebox shell is assembled it is turned on its back and its free ends are cut down level with the dot-punch line of the foundation ring by an automatic travelling milling tool of the Langbein system made by



LANGBEIN MILLING MACHINE FOR DRESSING THE EDGES OF BOILER RINGS.

the Esslingen Maschinenfabrik, Germany. In this the cutting disk is operated similarly to a small circular saw with feed motion. This tool is greatly approved at Winterthur and serves for other work besides, such as dressing boiler rings as shown by the photograph just above, made by the author at a large Italian locomotive works, the latter machine differing only in that it was made by the Esslingen Locomotive and Machine Co.'s branch works at Sarrono, Italy, and from this

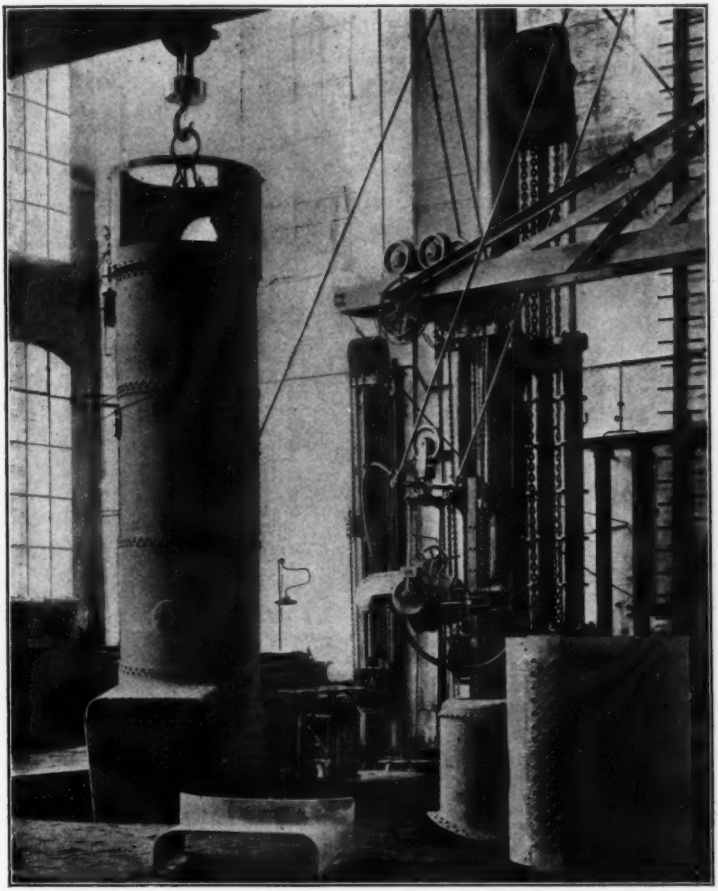


FIG. 3. HYDRAULIC RIVETTING PLANT AT THE WINTERTHUR WORKS.

view the feed and travelling motions will be understood without need of further description.

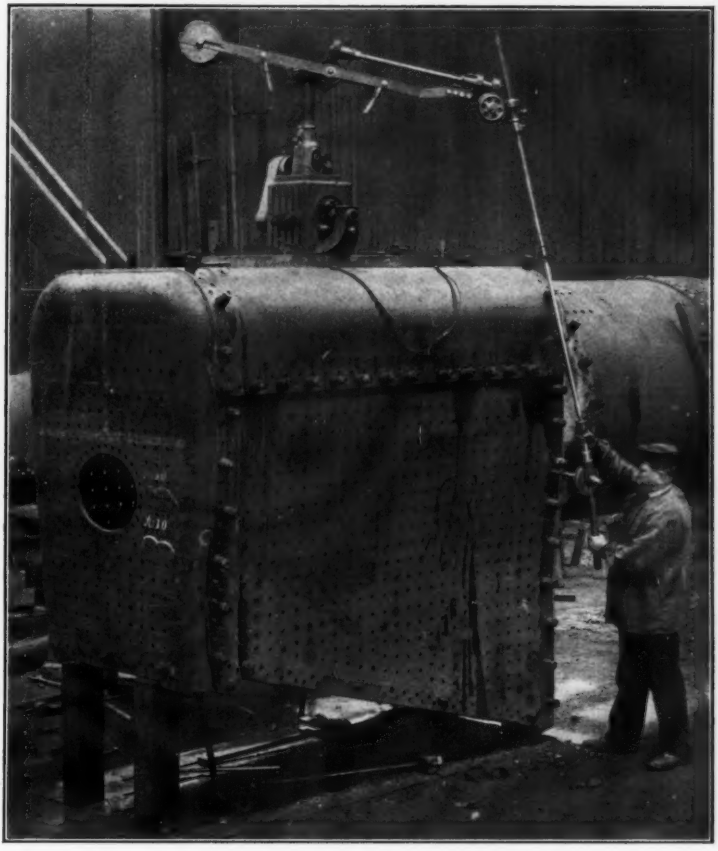
The sheets for the boiler rings are bent, the edges chamfered, holes drilled, and rivets then closed up by a hydraulic plant consisting of one large and one small rivetting machine shown in the view above, made by Brietfeld Laniek & Co. of Prag-Carolinenthal. This installation is located at one end of the boiler shop and the illustration shows the already rivetted boiler barrel assembled with a "basted" firebox

TAPPING HOLES FOR CROWN STAY BOLTS.

Courtesy of the manager of the Belfort works of the Société Alsacienne de Constructions Mécaniques.

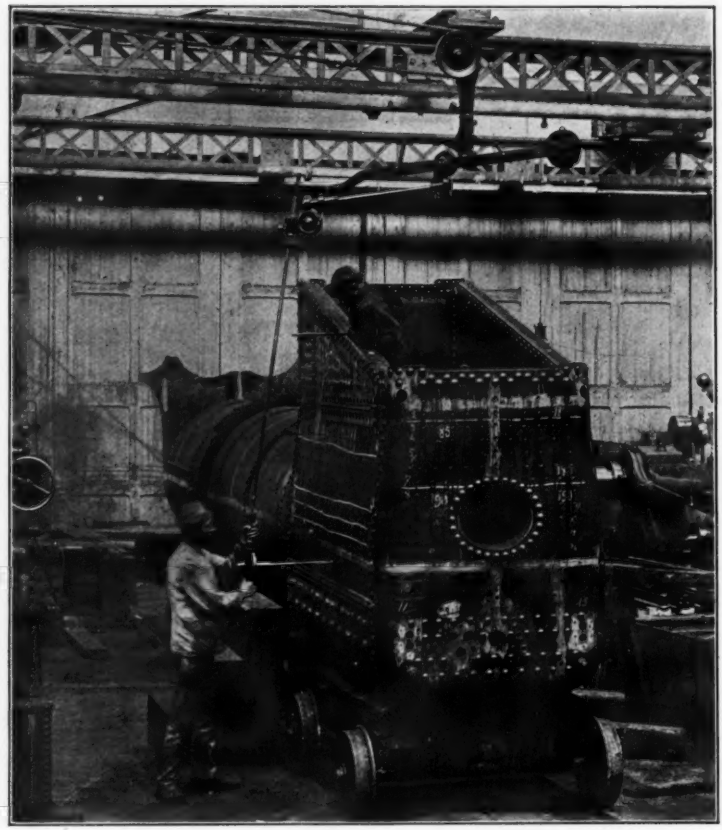
shell ready for being rivetted together. With this machine the longitudinal quadruple-rivetted seam of a ring 5 feet 10 inches long and comprising 84 rivets is finished within an hour. This work is handled over the boiler pit by a 20-ton hydraulic crane. The steam engine working the pumps of the hydraulic accumulator is of 80 horse power and the maximum water pressure is 120 atmospheres per square centimetre.

The foundation rings are completely milled on all sides by the various tools employed for this work and made by Oerlikon, Shultz



REAMING RIVET HOLES OF FIREBOX SHELL.
Courtesy of Société Alsacienne de Constructions Mécaniques.

(Mulhausen) and Kendal & Gent, and after a temporary assemblage and rivetting in place of the expansion slide-brackets, the inner box is inserted either from below through the front, or from behind, according to the type of boiler, and the final rivetting together of the two boxes is effected at the foundation-ring and firehole and followed up by the copper side-staying. The firebox stay holes are both reamed and tapped by means of a very handy universal drilling attachment run by a small electric motor called "The Belfort" and this is illustrated by the annexed photographs.



REAMING HOLES FOR COPPER SIDE STAYS.

These appliances are ordinarily attached to the casing of the motor itself for reaming and tapping crown stay holes as on page 848, and the side plate rivet holes as on page 849, or, when the boiler is turned over, and there is then no means of fixing it on the boiler itself, the swivelling arm can be affixed to any roof-girder bracket and motion then obtained by a cord drive from the same small and portable electro-motor, as shown in the illustration above.

With a current of 110 volts the force of the motor is about 3 horse power and the rate of tool speed is 125 revolutions. The inside and outside boxes can be reamed and tapped at the rate of a little under

one hole in three minutes. This appliance is said by the Winterthur company to give highly satisfactory results.

Copper screwed stays differ considerably according to the locomotive specifications. After the copper bars from which they are made have been screwed they are bored, partially or completely, on a double-headed stay-drilling machine, or in other cases the holes are already formed by the Mannesmann process as practiced by the noted firm of Heckmann of Duisburg, Germany.

Very often the holes in either extremity of copper screwed stays have a depth only just sufficient to penetrate into the water space, so that if the stay breaks near up to the plates, as it generally does, its situation can at once be located. At the works it was said that the outer holes are always closed up, since, unless ferrules be rivetted between the boiler and its metal sheathing, it is not possible to locate a leaking stay exactly. This does not appear to be corroborated in German practice wherein ferrules are not often used as is regularly done in Austria; moreover, I have seen Winterthur-built engines in repair shops with the stays opened out externally, although without knowing whether this was done by the builders or by the railroad company during repairs. Where the outside extremity is closed up by the rivetting it is of course necessary only to plug the inside end in awaiting the replacement of a broken stay. Manganese screwed stays are in some cases used at Winterthur for those upper and forward rows subject to the most strain, and around the firehole. Their ends are staved up to form a round head just as it is done with copper stays, but a small plug of iron is inserted in the outside hole and this, probably, serves to preserve the head to some extent from that disaggregation due to rivetting which has been observed in certain French works, where the yellow stays are now merely flattened down, with better results for this form of metal than has been the common experience in England.

The iron crown staybolts are cut off to the exact size before being screwed home, but for the copper screwed stays this is not done, or the exact reverse of the practice followed in some Italian locomotive works. At Winterthur the projecting ends of the copper stays are nipped off by a somewhat cumbrous compressed-air tool suspended from a crane and handled by one man (said to be an imitation of an American tool). This does its work very well when there is plenty of air pressure; otherwise the jaws fail to bite off the ends with the regularity desirable in such a machine. The speed of the operation is about two per minute when the misses are not counted.

In a special shop for lagging plates and brass work the tubes are

fitted with brass or copper ends, and this is effected by turning one end down to form a spigot, the other to form a socket, and between the two a brazing solder and flux is run and the joint finally dressed up. This operation is performed at the rate of twenty tubes per hour.

When the boiler is caulked and tubed, it is tested under water pressure and then run out of the shops into an open space, and there fired up for testing by steam pressure, after which it is taken to the erecting shop and dropped on to its frames ready for the steam piping and metal lagging.

General Machine Shops.—In the machine shops the best tools are the well-known machines from the Sellers, the Pond, the Cincinnati, the Bement-Miles and Ingersoll machine-tool companies, in addition to to others from Kendall and Gent, Smith & Coventry, Grafenstaden (Société Alsacienne), Chemnitz Maschinenfabrik, Oerlikon, etc. A multiple-head drill by Craven Brothers, able to bore eleven holes simultaneously, is to be noted in the equipment. A number of planers are still used where nowadays elsewhere milling tools are often employed. The best of these machines have a quick return-speed of 4 to 1, or 72 feet per minute.

Cylinders.—These are cast at the adjoining works of Gebruder Sulzer and are worked up and finally tested hydraulically by the railroad inspector. Later on, when completed, the locomotive is tested on one of the Federal lines, while narrow-gauge locomotives are tried upon a shop line of 650 yards length.

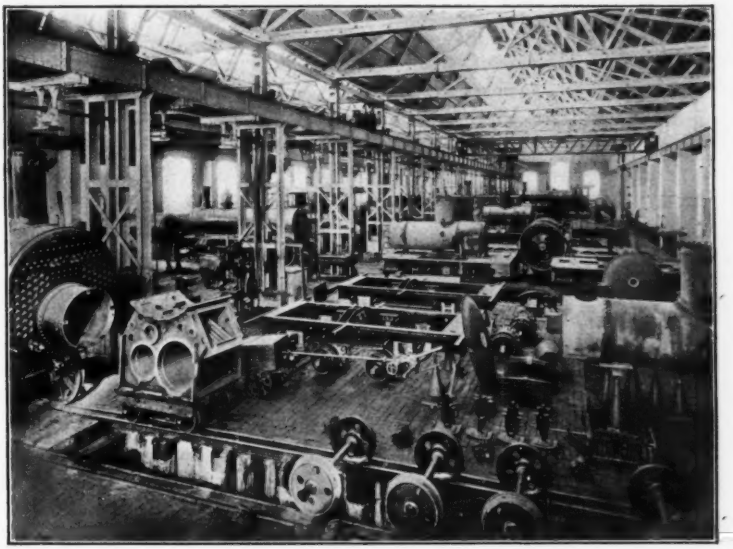
The large inside-cylinder castings are for two, three, and four-cylinder compounds. One of the first-named, for the locomotives of the Nord-Ost Bahn (now Bundesbahnen), is shown in the view of the erecting shop. Its inclined valve-seatings and the half-automatic starting-valve bore are here shown completely machined ready for the fitter. Other one-piece castings have a single inside low-pressure cylinder, and yet others have two equal-sized inside cylinders—hitherto always for high pressure, but now, quite recently, for low pressure and therefore according to French practice.* Piston rings or segments are cut from a turned and bored cylinder of cast iron, for which work vertical boring machines are always employed. Of these machines there are now in use for small work five, all of English make.

Steels for the various work are obtained variously from Germany, England, and Austria. Main driving rods, connecting side rods, and sometimes the reversing rods or weigh bars, are all channelled, and this is done by milling out in the ordinary way. The merit of the work

* The latest express engines of the Jura-Simplon Railroad.

done at Winterthur resides as much as anything in the motion details which are designed with especial care, the parts being very finely proportioned and as light as is possible, consistent with great strength.

Eyes and bushes for plain ends are ground after hardening on a grinding machine by Schmaltz of Offenback, the composition wheels having fast rotary and slow concentric movements and adjustable so that the eccentricity can be varied to suit different sized holes. The links of the valve motions, after being tempered, are ground up true on two special automatic grinding tools. Valve buckles ("cages") are one-piece forgings of Siemens-Martin steel—which is the kind of steel most often employed for the motion work. The cross-



THE ERECTING SHOP AT WINTERTHUR.

head bars, of which there is now a tendency to use only one for each cross head of outside cylinders, are said to be always hardened and ground up true after that process. There are ten grinding mills.

Frames.—After drilling the holes at the angles the frames are clamped by the half dozen to the bed of a large slotting machine and the pieces for the axle boxes or for lightening the frames are then removed. The plate frames for the Norwegian engine previously mentioned had the thickness of 1⅝ inches, which is of course very exceptional with European locomotives.

The side frames are braced together by transverse frames of steel castings. These are often of considerable length and the whole of their flanged edges, where rivetted to the side frames, are dressed upon a special milling machine made by the Oerlikon company. Were it convenient to dress by planing, grinding, or milling the inside surfaces of the side frames, the frame work of a Continental engine as now built up with so much steel castings and milled as described, would present a basis for such absolute correct jig and template work that measuring, squaring, and aligning appliances would be unnecessary for the erection of the engine and motion. At present this is not done, and at Winterthur, as elsewhere, the tight line and square have to be employed for verification.

Wheel Shop and Turnery.—In the wheel bay there are two large vertical turning machines for tires, one of American and the other of English origin. Wheel centres and axles generally come from Germany and the cranked axles are usually from Krupp's. At present the crank axles most often used are of the oblique type—that is, with only one right-angle web for each main driving-rod end. This forging is delivered entirely finished and has a very massive appearance, being of rectangular section, 10 by 12 inches, with rounded corners, and yet weighs about 550 pounds less than what may now be termed the old-fashioned straight-type crank axle. The cost of its forging is, however, higher than the latter pattern (2 to 3 per cent.). In nickel steel entirely finished it costs 4,000 francs. The webs are either circular or elliptical in form and the axles may be of neat round section, as are, for instance, those in the Italian-built express engines of the Roumanian State Railways.

When it has no inside eccentrics of the antiquated cam and strap type this form of axle is the one that is the most easily inspected and attended by engine men.

Erecting Shop.—A general idea of this shop may be had from the view page 853, from which it will be observed that steam street-car locomotives and street-railway electromotors are also assembled in this place, whence the cylinders and motion are brought direct from the machine shops; for it is necessary to say here that there is no stock magazine and work is gauged and checked on the spot. The parts are now mounted up and tested for alignment, but being all made very carefully to standard templates and gauges the accuracy of fit is generally perfect and the interchangeability of parts as certain as possible for locomotive work.

Smithy.—On account of the high price of coal all large forged work

is obtained from outside firms, principally in Germany, and thus, main connecting rods and similar work being imported, the work done on the spot is of a small kind only. In the smithy there are six steam hammers, the largest being of only half a ton.

Foundry.—As the cylinders, chimneys, and other large castings are obtained from Sulzer Brothers, the foundry work is reserved for smaller pieces. It is equipped with a 9-ton crane, but the new foundry will be of more importance and have a 25-ton crane.

Model-Makers' Shop.—Models or patterns are very finely made at these works, varnished, and preserved with care in a lofty well-aired building adjoining the wood-workers' shop. This latter, of moderate size, has its saws, planers, and lathes run by a 12-horse-power engine with Winterthur patent gasogene generator working by the aspiration of the motor.

Drawing Offices.—These are located on the first floor above the general offices. The drawing offices are divided into three parts—locomotives, gas-engines, and projects; and there are 40 draughtsmen employed altogether. The light in this open part of the country is ordinarily very good, but for night work shaded incandescent lamps are employed. The system of indirect lighting (reflected from the ceiling) sometimes employed in England has not been found to be satisfactory here, so each man has his own lamps, which he can hang at any desired height or position by a number of wire hooks upon a light pivoting bracket suspended from the ceiling. The tables have cast-iron pedestals which formerly could be regulated for height—an arrangement now abandoned. In the special room for projects—a quiet room with subdued light, apart from the others—a vertical adjustable drawing board was noted, the draughtsmen sitting or standing as before an easel. The square or straightedge for base lines is hung upon cords passing over pulleys in connection with a counterweight, and a grooved ledge in the straightedge contains drawing tools, set squares, and ink, so that all lines should be geometrically accurate without special effort on the part of the draughtsman. The board can be inclined at any angle and there are drawers attached to the pedestal for papers etc. The makers are Billweller & Kradolfer of Zürich and Siegrist of Schaffhouse. Despite its obvious advantages it appears that the young men prefer to lie across a table and perhaps lay up a case of appendicitis, rather than accept the offer of such a board.

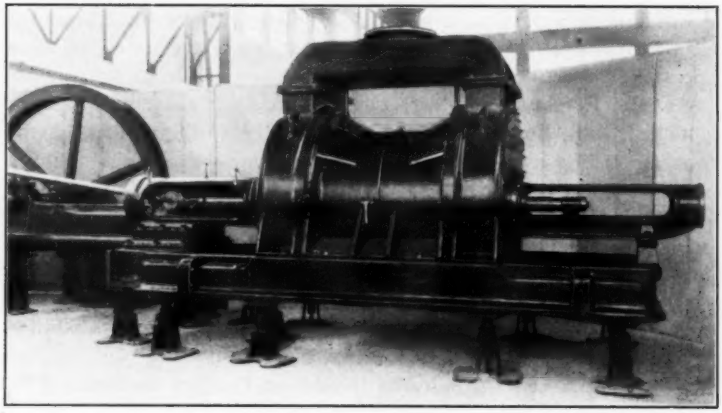


FIG. 16. EHRHARDT & SEHMER MINE PUMP.

ELECTRIC POWER APPLIANCES IN THE MINES OF EUROPE.

By Emile Guarini.

In a preceding article M. Guarini took up a general review of Continental practice in the secondary operations of signalling and lighting. The present paper deals with the more direct applications of electricity to the work of ore getting and ore handling.—THE EDITORS.

THE primary applications of electricity to power purposes in European mining practice fall into four groups. First stand the uses directed to the safety of the mine and the mine workers; these are for the operation of the pumping and ventilating machinery. Second come the direct applications to ore getting, including the driving of drills and mining machines, and the electric firing of shots. The third group comprises the applications to the transport of the ore and includes locomotives and tramming, hauling, and hoisting machinery. Finally, the fourth group of applications are those concerned in the treatment of the ore after extraction—in stamp mills, crushers, screens, etc.

The direct operation of mine-drainage pumps is one of the most troublesome problems the electrical engineer has had to solve, on account of the very high speed of the electric motor and the very slow speed of the mine pump. Builders of motors and of pumps have approached each other by a series of concessions, the former slowing

down and the latter speeding up their respective machines. From this has resulted the so-called "express pumps" made by many firms—among other builders on the Continent, by Ehrhardt & Sehmer, the Maschinenbau Anstalt of Breslau, Riedler & Stumpf, Hope of Berlin, and Jaudin of Lyons. The pumps of Ehrhardt & Sehmer are specialised by their mechanical construction, of which Figure 16 gives a general idea. The plungers are single-acting, the valves vertical-lift and superposed. The valve seats are held by lateral studs; the plungers are worked directly by the rod. The volumetric efficiency is 94 to 96 per cent. The pumps are built single, duplex, and triple. A notable example is the triple pump of this make installed at the Marlesen collieries in 1902. The required duty was 4,200 to 4,300 litres per minute at 160 revolutions. The stroke of the plungers is 315 millimetres, their diameter 194 millimetres, their area 2.956 square decimetres (45.8 square inches), and the discharge volume for a single revolution 27.94 litres; the actual efficiency is 4,500 to 4,600 litres per minute at 171 revolutions, with a lift of 268 metres. The efficiency of the electric motor is 96 per cent; the mean volumetric efficiency of the pump is 95 to 96 per cent; the mechanical efficiency is 83 per cent, and the total efficiency 64 per cent. In another installation with a triphase motor at 2,400 volts the total efficiency is 68.6 per cent.

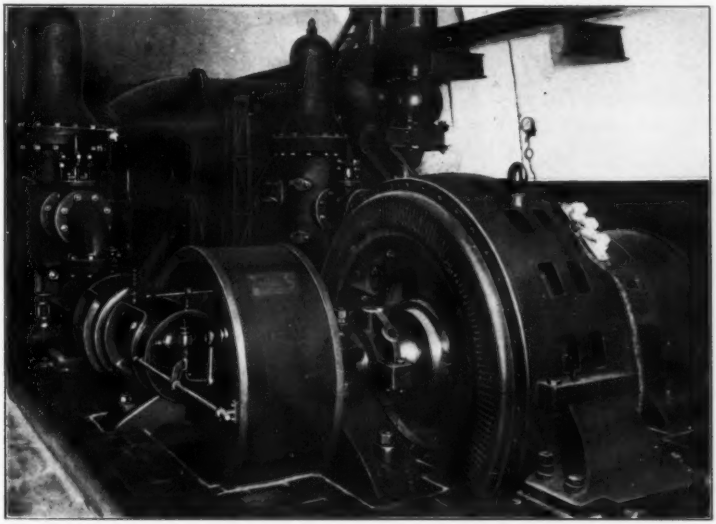


FIG. 17. ELECTRIC-DRIVEN PUMPING PLANT, GELSENKIRCHEN MINING COMPANY.

Figure 17 shows the electric-driven pumping plant of the "Germania I" shaft of the Gelsenkirchen mining company. This installation, put in by the Helios Company, operates a duplex pump by Bergman of Breslau, of a capacity of 3 cubic metres per second at a velocity of 180 revolutions and a lift of 160 metres. The direct-coupled polyphase Helios motor develops 160 horse power at 2,200 volts.

The Riedler-Stumpf pump is characterised by having the suction valve concentric with the plunger and also by its speed, rising to 300 revolutions. The first electrically equipped Riedler pumps were installed at Leopoldshall in 1899. Later installations have been made at the Aumetz-Friede, Kübeck, Engelsburg, and other shafts. In the cases last named the pumps run at 200 revolutions; their capacity is 2.5 cubic metres per minute with a lift of 570 metres. They are driven by triphase motors made by the Allgemeine Elektricitäts Gesellschaft, taking current at 2,300 volts and 110 periods per second.

The Jaudin pump, like the preceding, permits speeds of 300 revolutions. A Jaudin pump installed by the Oerlikon Company at the Monterrad shaft at Firminy has a capacity of 2.7 cubic metres at 100 revolutions with a lift of 285.5 metres. It is direct-coupled to a 200-horse-power triphase Oerlikon motor making 100 revolutions and taking current at 970 volts and 20 periods.

The Oerlikon Company, however, prefer pumps of moderate speed to the express type, on account of the rapid wear of the latter. In this view they installed, at the Kaiserstuhl II shaft at Dortmund, a Hoppe pump of 5 cubic metres' capacity at 75 revolutions with a lift of 400 metres, direct-driven by a triphase asynchronous motor of 570 horse power. The English companies also seem to prefer slow-speed pumps; the Westinghouse Company, for example, supplied to the Sneyd colliery a pump driven by a 30-horse-power triphase motor for a duty of 62 gallons lifted 780 feet, and to the Oak Bank Oil Company, centrifugal pumps direct-coupled to three triphase motors of 5 horse power each for pumping 4,000 gallons per hour to a height of 40 feet.

In the case of small pumps the coupling with electric motors presents no difficulties; the energies of the Siemens & Halske, Schückert, Union, and other companies referred to have therefore been directed toward large pumping plant. Their perseverance is explained and warranted by the great superiority of electricity as a motive power in this connection. The first cost, as compared with that of steam plant, it is true is somewhat higher; but the daily running expense is less, the energy losses are lower, the wear and tear of generating machinery and driving motors are very small, and finally electricity is without

the objection of impairing the ventilation of the mine and affecting injuriously the timbering, both of which defects apply in the case of the use of steam with its necessary piping.

Ventilation is almost as important as pumping to the safety of the mine, and the electric operation of ventilating machinery does not offer the same difficulties. It is effected by direct coupling, by belts, and by

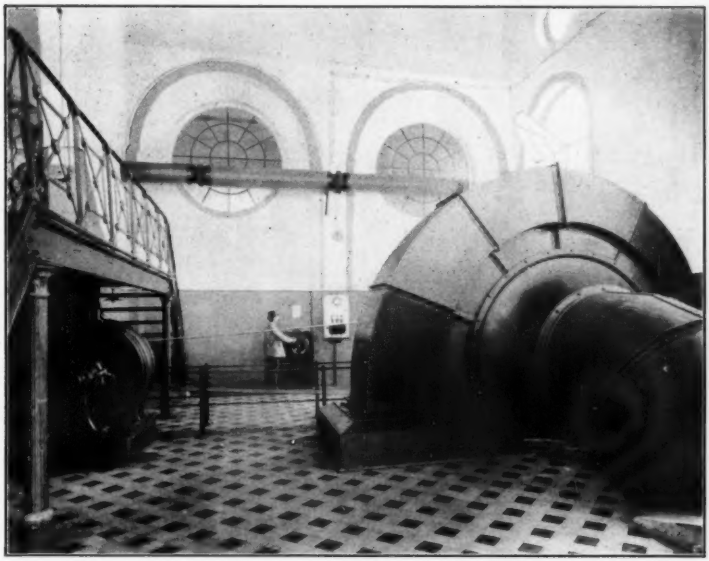


FIG. 18. VENTILATING FAN OF THE GLÜCKAUF MINE, SONDERSHAUSEN.

flexible shafting. Mine ventilators are of two sorts—those placed in the levels or other parts of the workings for local ventilation, and the large ventilating fans at the head works. These latter may be regulated either through the mechanical power transmission, by the alteration of the area of the air intake, or, when driven by direct-current motor, by changing the speed.

Figure 18 shows the ventilating fan of the Glückauf mine at Sondershausen. It is belt-driven in order to facilitate speed changes. The motor (of Siemens & Halske manufacture) is of 100 horse power and 500 volts. Although the fan is in the immediate neighbourhood of the steam plant, electric driving is preferred on account of the saving in labour of oversight which it permits.

Almost all the electric companies mentioned heretofore in these articles have done more or less important work in the way of electric

ventilating plant for mines. To mention a few instances only there is the installation of the Germania II shaft (Helios) with a 2,000-volt polyphase motor of 400 horse power; that of the Hollertzug mine, put in by the Allgemeine Elektricitäts Gesellschaft; that of the Karwin mines, by Siemens & Halske, etc. All these examples agree in supporting the claims for the economy, simplicity, and convenience of the electrical system.

Electric operation of drills is the most important application to the direct processes of ore getting, but it has to make its way against a most powerful competitor—compressed air. The advantages of the latter for percussion drills are indeed such that the Schückert Company have retained it to the full as the actual operative agency, merely doing away with the disadvantages due to the use of piping. With this aim they have designed the apparatus shown in Figure 19—an air compressor driven by an electric motor with a compressed-air reservoir, all arranged to run on rails and to be thus moved to the ore breast. By this means the inconvenience of long air mains is avoided, the power being brought close to the point of actual application in the

FIG. 19. ELECTRIC-DRIVEN AIR COMPRESSOR FOR MINING DRILL OUTFIT.

form of electric current, by the more convenient electric cables. In this respect, however, Schückert practice differs from that of other companies, which have designed drills driven altogether by electricity.

Rotary drills work well in soft rock, but for hard rock the percussion type is preferable. Electric driving of rotary drills presents no difficulty; it is effected either by direct coupling of the motor to the

FIG. 20. ROTARY MINE DRILL ELECTRIC-DRIVEN THROUGH FLEXIBLE SHAFT.

drill, as in the practice of the Union Elektricitäts Gesellschaft, the boring bit being driven through gearing by a 2-horse-power motor—or (the practice just described not having met with general adoption by other companies) the transmission may be by flexible shaft as shown in Figure 20, which represents a rotary drill installed by the Siemens & Halske Company in the Charles-Ferdinand drift at Gross-Hettingen. Percussion drills, on the contrary, are not at all so easily adapted to electric driving. The many efforts made have resulted in three principal systems—the solenoid, the cam, and the Siemens & Halske crank.

In the solenoid system there is a coil divided into two sections and surrounding an iron core. Current is sent through the sections alternately, and the core alternately attracted in opposite directions. The drill bit is in direct connection with the core and receives the necessary turning movement from a pawl actuated by the reciprocating movement of the core. This drill has the advantage or requiring no motor; it has the defects of low power and of heating.

In the second system the drill is driven by a cam fixed on a shaft revolving at 300 to 350 revolutions; the cam engages a small wheel on the breech of the percussion drill and drives it backward, compressing a spring which gives the forward blow as soon as the cam releases the disk. The objections offered to this system are that it does

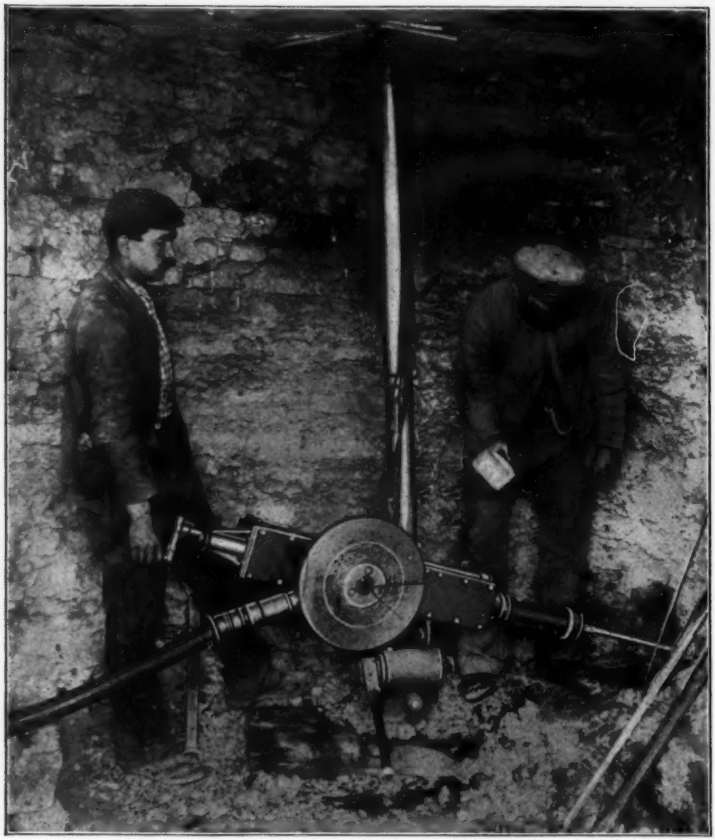


FIG. 21. ELECTRIC MINING DRILL, PERCUSSION TYPE, CRANK SYSTEM.

not work as well overhead as downward, and that it requires close synchronism between the movement of the cam and that of the breech.

The crank system employs a crank shaft which, by a small bronze slide block working on a steel slide, imparts a reciprocating motion to a carriage. Two strong spiral springs are set between the end plates of the carriage, and between these is the "percussion box" inside which is the breechblock of the drill; this is free to move inside the springs and transversely to the end plates of the carriage. Figure 21 illustrates this drill for which the makers claim the following advantages: regular and equal force of the drill blow in any position of working; absence

of shock to the mechanism; and high power and high speed (420 to 450 strokes per minute). It is objected to, on the other hand, on account of its complicated construction, its liability to derangement, its rapid wear, and the frequent and large expenses resulting therefrom.

A Schückert drill of mixed type, in the Friedrich Wilhelm mine, working in hard sandstone and hematite, advanced the gallery 24.8 metres in 248 hours. Cam drills of the Electricité et Hydraulique company's make, in a trial of four or five months in the Courcelles colliery, showed a gain in drifting of .80 metres by machine as against .40 metres by hand drilling in equal time, with a cost of 60 francs a metre for the machine work as against 103 metres with hand drilling. Lastly the cam drill in the Kotterbach mine in Hungary, working in moderately hard spathic iron ore, showed a record of 12.5 metres drilled in 9 hours. The rate of actual boring was from 5.5 to 6 centimetres a minute.

In addition to mining drills, coal-cutting machines are used to advantage in colliery working, notably the Sullivan system exploited by the Union Elektricitäts Gesellschaft. This machine, of American origin, consists essentially of a chain carrying cutters and carried around two pulleys driven by an electric motor.

Electric firing is accomplished in two ways—by the electric spark and by the incandescent platinum wire. The latter is usually preferred on account of its greater certainty. Magneto machines are used when the number of shots to be fired is small, but when this rises to 80 or over a dynamo current is employed. In the Siemens & Halske magneto-electric firing key, an arrangement prevents the closing of the circuit before the induced current has reached its full value. The premature firing of the more sensitive fuses is thereby avoided. In the dynamo exploder made by the same company the induced current is controlled by a spring which is raised. When the electromotive force reaches the maximum the circuit is closed automatically, thus insuring the simultaneous explosion of all the shots.

For carrying the ore from the breast of the stope to the adit or level, small motor-drawn trucks are used. The speed is ordinarily from 1 to 1.5 metres per second with a 5 to 10-horse-power motor and a grade of 10 to 15 degrees. Figure 22 shows one of these motors for an incline in the mines of the Kaliwerke Aschersleben, installed by Siemens & Halske. It draws the cars from the working face to the main haulage road of the mine.

Where the level is straight, the haulage distance not too long, and the traffic regular, endless-rope haulage is often employed. In this case

the speed of the hauling rope does not generally exceed one metre per second, so as to permit trams to be attached or detached without stoppage; the track is also double. A commutator permits the motion to be reversed in case of derailment. Figure 23 shows the haulage plant installed by the Westinghouse Company at the Sneyd colliery, Staffordshire. Electric rope haulage has found wide application in mining work, and all the larger companies have put in important installations. The mines of Planitz, Gottessegen, Rhenania, Lyden-

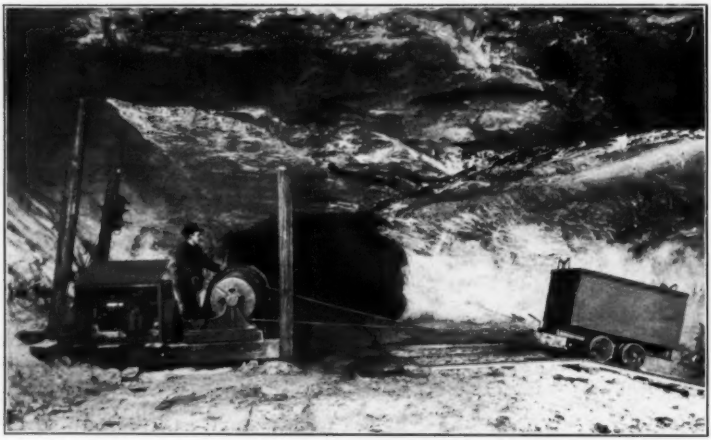


FIG. 22. HAULAGE BY ELECTRIC MOTOR, MINES OF THE KALIWERKE ASCHERSLEBEN.

burg (South Africa), Shimoyamada (Japan) etc. have Siemens & Halske equipment; Schückert installed the plant at the Zwickauer Steinkohlenbau Vereins, the Altgemeinde Bockwa, etc.; Gans furnished electric haulage machinery for the mines of Kivald, Tokod, Resicza, Nagy-Manyok, and many other workings.

When rope haulage is not feasible, on account of the great length or the crookedness of the levels, electric locomotives are sometimes used to haul the trams either to the open, as in the Hollertzug mine, or to the shaft. Electric locomotives are employed also for moving the ore to or from the concentration works or the stockpile. For surface transport use is made also of electric telpherage, as shown in the installation by the Union Elektricitäts Gesellschaft illustrated in Figure 24. For locomotives the direct current is usually preferred to the alternating, because it necessitates but one or two conductors and so encumbers the mine openings less.

The regular mine locomotive made by the Union is 260 centimetres

long, 108 centimetres in breadth; the wheel base is 72 centimetres, and the diameter of the wheels 50 centimetres. The maximum elevation of the trolley wire is 140 centimetres. The locomotives for the surface work are of larger dimensions and take current by an aluminium roller which does not have to be reversed, like the trolleys, in case of a reversal in the direction of running.

At the Hollertzug mine, already referred to, the Allgemeine Elektricitäts Gesellschaft has furnished one locomotive for underground and another for the surface workings. The former is equipped with a geared motor of 10 to 15 horse power, starting being regulated by means of resistances. This locomotive pulls a train of twenty waggons of a total weight of 1,400 kilogrammes each at a speed of 1,800

FIG. 23. ELECTRIC HAULAGE PLANT, SNEYD COLLIERY, STAFFORDSHIRE.

metres in 10 minutes—about 6¾ miles an hour. The surface locomotive is equipped with a 25-horse-power motor and hauls six loaded waggons 725 metres in 4½ minutes with a consumption of 3.7 kilowatts.

The Siemens & Halske locomotives have a speed of 10 to 15 kilometres an hour. The starting and speed-regulating resistances are placed under the frame carrying the couplers. Figure 25 shows an electric mine locomotive of this make at the rock-salt mines of Neustassfürt, near Stassfürt, Germany. The Baldwin-Westinghouse

locomotives supplied to the Oak Bank Oil Co. pull a load of 85 tons at a speed of 10 miles an hour. The alternating-current locomotives furnished by Ganz to the iron mines of Vajda-Hunyad exert a tractive effort of 600 pounds; their speed is 7½ miles and their weight 3.4 tons.

Less progress is to be noted, however, in the adaptation of electric driving to the operation of mine hoisting engines, on account of the difficulties presented by this particular work. These lie in the coupling of the motor to the winding drum and in the regulation of the speed. Direct coupling requires that the speed of the motor and the diameter of the drum shall both be reduced. Speed regulation is effected in various ways. With direct current, use may be made, for example, of two motors, each of half the requisite power. Connection in series or in

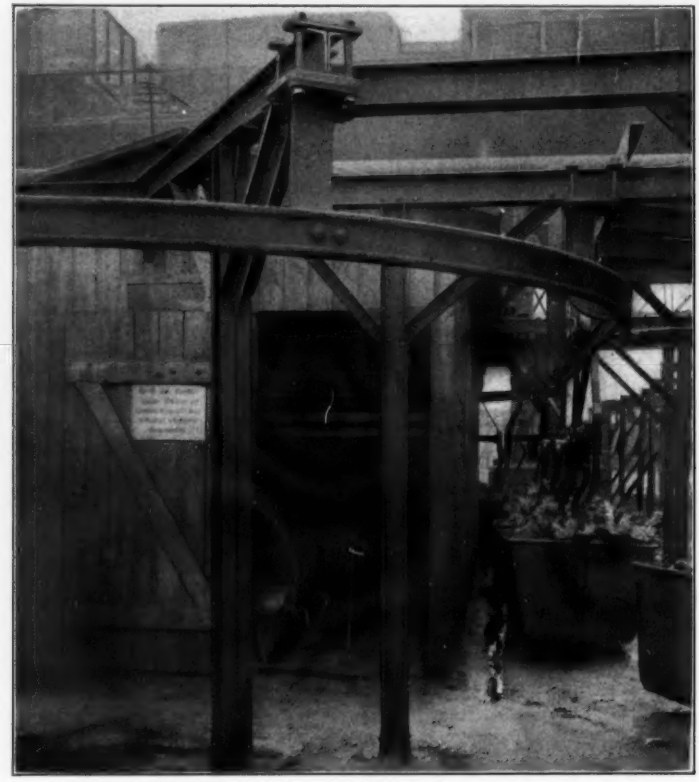


FIG. 24. ELECTRIC TELPHERAGE FOR SURFACE TRANSPORT AT A MINE.

FIG. 25. ELECTRIC MINE LOCOMOTIVE, NEUSTASSFÜRT ROCK-SALT MINES.

parallel gives half or full speed. The Allgemeine Elektricitäts Gesellschaft make use of a liquid rheostat, the liquid reaching an overflow when the motor attains its full speed. Starting, speed regulation, and stopping have also been controlled by varying the excitation of the dynamo. Finally, resistances have been employed to the same effect, though not to very good advantage. Constructors have therefore given much attention to safety appliances, and hoisting machinery is generally well equipped with many safeguards—powerful brakes operated by hand, by foot, by compressed air, or automatically if the cage passes the upper landing. The automatic brake acts by cutting off the current. Another automatic device, on the other hand, comes into play if, for any cause, the circuit is unintentionally broken. In such case a powerful electromagnet is demagnetized and lets fall a weight which operates the brake.

Direct connection of the motor and the drum is hardly ever adopted except in large installations. In small ones the connection is by gearing. Figure 26 illustrates an underground hoisting equipment operated by an open type Helios motor. At the Germania I shaft this company put in an electric hoist capable of lifting a net load of 1,800 kilo-

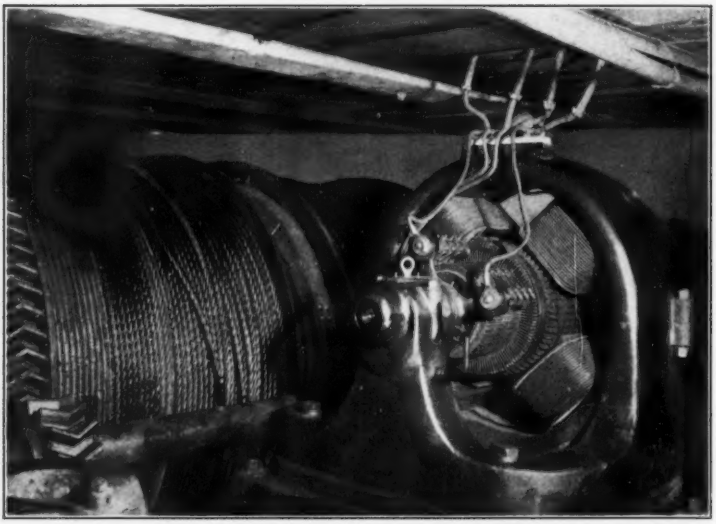


FIG. 26. UNDERGROUND HOISTING EQUIPMENT WITH OPEN TYPE MOTOR.

FIG. 28. ELECTRIC HOISTING PLANT, CONSOLIDIERTE ALKALIWERKE WESTEREGELN.

grammes from a depth of 450 metres at a speed of 3 metres a second; it is operated by an asynchronous polyphase motor of 120 horse power at 485 revolutions and 2,000 volts. The Rhein-Elbe installation is also noteworthy.

The main hoisting plant shown in Figure 27 is constructed by the Union Elektricitäts Gesellschaft. It is driven by two motors of 90 horse power at 500 volts. The hoisting speed is 2 metres per second with passengers and 4.2 metres per second with ore buckets, the depth being 220 metres and the net load 600 kilogrammes. The drums are 3 metres in diameter, and are driven by gearing. Another example of driving by gears is found in a hoisting plant installed in a fiery mine in Belgium by the Société Electricité et Hydraulique. The

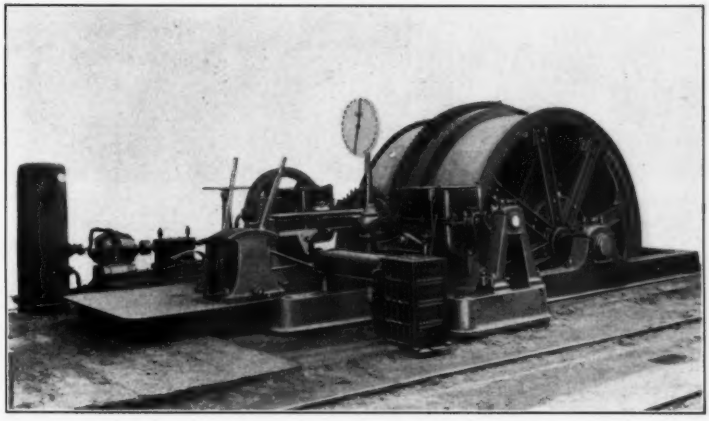


FIG. 27. MAIN HOISTING PLANT, ELECTRIC-DRIVEN BY GEARED MOTORS.

motor—of enclosed type, for 500-volt triphase current—is of 50 horse power with an overload capacity of 80 horse power, 600 revolutions; the net load is 2,000 kilogrammes which is hoisted from a depth of 100 metres at a speed of 1.5 metres per second.

The Schückert hoist exhibited at Düsseldorf had a special device for speed regulation by means of a counter electromotive force. The contra-tension was gradually reduced, allowing the motor to come up to speed. This machine was designed to take a working load of 1,400 kilogrammes from a depth of 400 metres at a speed of 15 metres a second. The three drums were each 2.5 metres in diameter. Important installations have been made also by Siemens & Halske at the Hohenegg shaft of the Karwin mines, at Erzherzog, Thiederhall, and at the

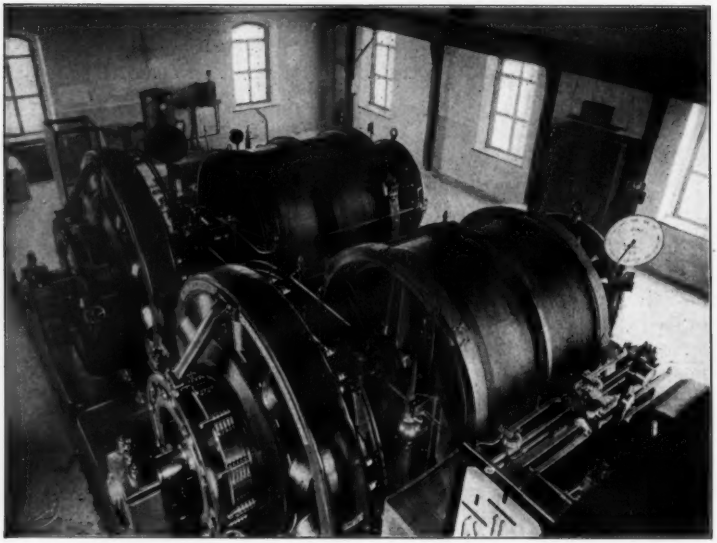


FIG. 29. ELECTRIC WINDING PLANT, ARNIM COLLIERY, NEAR PLANITZ.

Consolidierte Alkaliwerke Westeregeln. Figure 28 represents this last-named installation. The motor is of 60 horse power at 500 volts. The Hohenegg hoist is driven by a 170-horse-power triphase motor at 150 revolutions. The maximum load is 1,400 kilogrammes and the speed 4 metres per second from a depth of 260 metres. At the Erzherzog shaft a geared motor making 150 revolutions lifts a load of 2,800 kilogrammes at a speed of 4.5 metres a second. The Thiederhall hoist handles a duty of 200 tons (metric) in 8 hours; the depth is 200 metres, and a 500-volt motor, direct-connected, handles the load of 800 kilogrammes at a speed of 6 metres per second. For hoisting persons this speed is reduced to 3 metres per second.

Direct connection is employed also in the plant put in by the Allgemeine Elektricitäts Gesellschaft for the Preussen II collieries at Dortmund and the Arnim coal mines near Planitz. The former is designed to hoist 100 tons an hour from a depth of 700 metres. 2,200 kilogrammes is the net load, the weight of the cage being 3,800 kilogrammes, that of the four waggons 1,400 kilogrammes, and that of the cable 4,900 kilogrammes, a total of 12,300 kilogrammes. The speed is 16 metres a second, but this may be reduced to 5 metres. The motor is for triphase current of 2,000 volts with liquid rheostat for regulating

the starting. There is a safety brake operated by compressed air, and an automatic brake operating the safety switch.

The Planitz installation is shown in Figure 29; it differs from the one just described in that it is for continuous current, at 500 volts, the motors making 80 revolutions. It raises from 600 to 700 tons from a depth of 220 metres in 10 hours. The winding drum is directly over the shaft. 600 kilogrammes of coal and 1,000 kilogrammes of waste constitute the working load, the cage weighing 700 kilogrammes, the waggons 275 kilogrammes, and the cable 345 kilogrammes. The hoisting speed is 8.5 metres a second, reducible to 3 metres. Each drum is driven by a 225-horse-power motor and is 224 centimetres in diameter by 85 centimetres in width.

While the use of electric power in mine hoisting is not yet very common, it will not fail to extend rapidly now that the necessary standard of success has been attained. It is stated, indeed, that at the Heinrichschacht shaft the adoption of electric hoisting effected an economy of 1/3 in the fuel alone, to take no account of the saving in wear and tear or in lubricants. Further, the adoption of electric power in this work allows of the use of a buffer battery to store power during the descent of the cage. Steam gives no corresponding advantage.

Its large capacity for overload gives the electric motor an advantage also in the treatment of the ore after it has been raised. It serves well, for example, for the coal washery, for screening and grinding, for crushing and concentration of ores, and for the charging and drawing of coke ovens. It is highly adapted also to the conveyors, endless belts, and other transport machinery and to the operation of air compressors for rock drills, etc. It is impossible to do more than suggest a few of the many possible installations. It is well to note, however, that the motors are generally placed in a special location and enclosed so as to be removed from the action of injurious gases, etc., which might cause them damage. In such case the machinery may be belt-driven.

The endless-belt conveyor shown in Figure 30 is a Siemens & Halske installation for the handling of coal and is operated by a 15-horse-power motor. The Westinghouse Company furnished the Oak Bank Oil Co., in Scotland, with a 30-horse-power motor for driving a crusher for clay-slate and a 10-horse-power motor for the conveyor bringing the slate. A stamp mill run by a Johnson & Philips motor is at work at the Raub gold mines. At the Scharnhorst shaft is a coal washer, a mud pump, a screen, a breaker, and an elevator driven by Helios asynchronous polyphase motors of capacities running from 10 to 100 horse power. At the Hollertzug shaft the Allgemeine Elek-

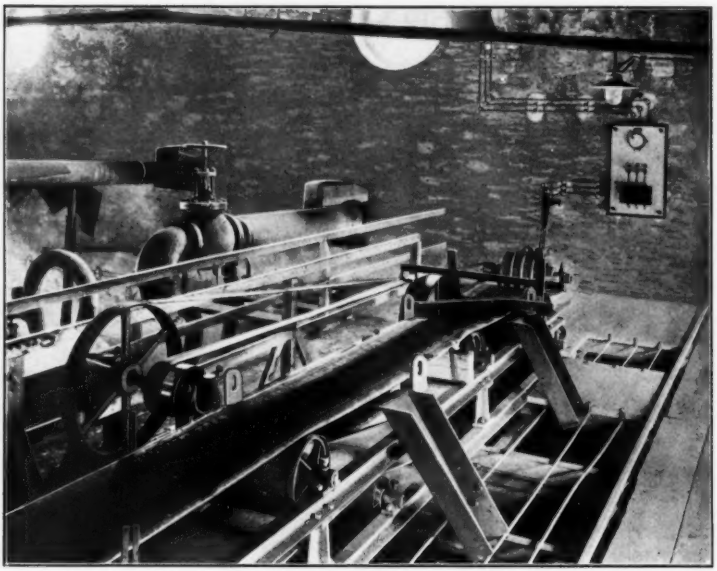


FIG. 30. ENDLESS-BELT CONVEYOR FOR HANDLING COAL.

tricitäts Gesellschaft put in a three-cylinder air compressor driven by a 40-horse-power motor.

A notable plant is that supplied by the Schückert company to the Altgemeinde Bockwa at Zwickau. It comprises two motors for the preliminary treatment, one for the washing, two for the lifts, one for a circular saw, one for a forge blower, etc. Important installations of the same kind have been made by Ganz also, as notably at Vajda-Hunyad, at the mines of Count Larisch-Mönnich, etc.

This brief *résumé* does not begin to exhaust the subject, but it may serve to make two points clear. The first is the activity which reigns in Europe in the introduction of electric mining machinery. The second is the economy which this introduction may secure. I will cite but two examples in closing.

Prior to the introduction of electricity, the Burma Ruby Mines were unable to make any dividends, the expense of operation being too high. Since its adoption, the expenses have been reduced, by the sum of £6,000 per annum, permitting the payment of profits. And at the Sheba mine, the economy in operating expenses since the introduction of electric power in 1896 has amounted to £10,000 per annum.

ALUMINIUM CONDUCTORS FOR ELECTRIC TRANSMISSION LINES.

By Alton D. Adams.

The substitution of aluminium for copper in electric-power transmission lines, though of much importance technically, industrially, and commercially, has been little discussed and the literature of the subject is scanty. Mr. Adams' brief but satisfactory presentation of the matter as it appears in the light of present conditions and immediate prospects is therefore of much interest and value. It will appeal particularly to those of our readers and correspondents who have recently asked for information on this phase of practice.—THE EDITORS.

LUMINIUM lines are now employed for the three longest electrical transmissions in North America. In the longest single line, that from Electra power house to San Francisco, a distance of 154 miles, aluminium is the only conductor used. The 144-mile transmission between Colgate and Oakland is carried out with three aluminium and three copper line wires. For the third transmission in point of length, that from Shawinigan Falls to Montreal, a distance of 85 miles, three aluminium conductors are employed.

The three transmissions just named have unusually large capacities as well as superlative lengths, the generators in the Electra plant being rated at 10,000, in the Colgate plant at 11,250, and in the Shawinigan plant at 7,500 kilowatts. Weight and cost of such lines are very large. For the three number 0000 aluminium conductors, 144 miles each in length, between Colgate and Oakland, the total weight must be about 440,067 pounds, costing $132,020 at 30 cents per pound. Between Electra and Mission San Jose, where the line branches, is 100 miles of the 154-mile transmission from Electra to San Francisco. On the Electra and Mission San Jose section the aluminium conductors comprise three stranded cables of 471,034 circular mils each in sectional area and with a total weight of about 721,200 pounds. This section alone of the line in question would have cost $216,360 at 30 cents per pound. The 85-mile aluminium line from Shawinigan Falls to Montreal is made up of three stranded conductors each with a sectional area of 183,708 circular mils. All three conductors have a com-

bined weight of about 225,300 pounds and at 30 cents per pound would have cost $67,590.

Aluminium lines are not confined to new transmissions but are also found in additions to those where copper conductors were at first used. Thus, the third transmission circuit between the power house at Niagara Falls and the terminal house in Buffalo, a distance of 20 miles by the new pole line, was formed of three aluminium cables each with an area of 500,000 circular mils, though the six conductors of the two previous circuits were each 350,000 circular mil copper.

From these examples it may be seen that copper has lost its former place as the only conductor to be seriously considered for transmission circuits. Aluminium has not only disputed this claim for copper but has actually gained the most conspicuous place in long transmission lines. This victory of aluminium has been won in hard competition. The decisive factor has been that of cost for a circuit of given length and resistance.

From the standpoint of cross-sectional area aluminium is inferior to copper as an electrical conductor. Comparing wires of equal sizes and lengths the aluminium have only 60 per cent. of the conductivity of the copper, so that an aluminium wire must have 1.66 times the sectional area of a copper wire of the same length in order to offer an equal electrical resistance. As round wires vary in sectional areas with the squares of their diameters, an aluminium wire must have a diameter 1.28 times that of a copper wire of equal length in order to offer the same conductivity.

The inferiority of aluminium as an electrical conductor in terms of sectional area is more than offset by its superiority over copper in terms of weight. One pound of aluminium drawn into a wire of any length will have a sectional area 3.33 times as great as one pound of copper in a wire of equal length. This follows from the fact that the weight of copper is 555 pounds while that of aluminium is only 167 pounds per cubic foot, so that for equal weights the bulk of the latter is 3.33 times that of the former metal. As the aluminium wire has equal length with and 3.33 times the sectional area of the copper wire of the same weight, the electrical conductivity of the former is $3.33 \div 1.66 = 2$ times that of the latter. Hence, for equal resistances, the weight of an aluminium is only one half as great as that of a copper wire of the same length. From this fact it is evident that when the price per pound of aluminium is anything less than twice the price of copper, the former is the cheaper metal for a transmission line of any required length and electrical resistance.

The tensile strength of both soft copper and of aluminium wire is about 33,000 pounds per square inch of section. For wires of equal length and resistance the aluminium is therefore 66 per cent. stronger because its area is 66 per cent. greater than that of a soft copper wire. Medium hard drawn copper wire such as is most commonly used for transmission lines has a tensile strength of about 45,000 pounds per square inch, but even compared with this grade of copper the aluminium wire of equal length and resistance has the advantage in tensile strength. While the aluminium line is thus stronger than an equivalent one of copper, the weight of the former is only one-half that of the latter, so that the distance between poles may be increased, or the sizes of poles, crossarms, and pins decreased with aluminium wires. In one respect the strain on poles that carry aluminium may be greater than that on poles with equivalent copper lines, namely in that of wind pressure. A wind that blows in any direction other than parallel with a transmission line tends to break the poles at the ground and prostrate the line in a direction at right angles to its course. The total wind pressure in any case is obviously proportional to the extent of the surface on which it acts, and this surface is measured by one-half of the external area of all the poles and wires in a given length of line. As the aluminium wire must have a diameter 28 per cent. greater than that of copper wire of equal length, one-half of the total wire surface will also be 28 per cent. greater for the former metal. This carries with it an increase of 28 per cent. in that portion of the wind pressure due to wire surface. In good practice the number of transmission wires per pole line is often only three, and seldom more than six, so that the surface areas of these wires may be no greater than that of the poles. It follows that the increase of 28 per cent. in the surface of wires may correspond to a much smaller percentage of increase for the entire area exposed to wind pressure. Such small difference as exists between the total wind pressures on aluminium and copper lines of equal conductivity is of slight importance in view of the general practice by which some straight as well as the curved portions of transmission lines are now secured by guys or struts at right angles to the direction of the wires.

Vibration of transmission lines and the consequent tendency of crossarms, pins, insulators and of the wires to work loose is much less with aluminium than with copper conductors as ordinarily strung, because of the greater sag between poles given the former, and also, probably, because of their smaller weight. An illustration of this sort may be seen on the old and new transmission lines between Niagara

Falls and Buffalo. The two old copper circuits consist of six cables of 350,000 circular mils section each on one line of poles, and are strung with only a moderate sag. In a strong wind these copper conductors swing and vibrate in such a way that their poles, pins, and crossarms are thrown into a vibration that tends to work all attachments loose. The new circuit consists of three 500,000 circular mil aluminium conductors on a separate pole line strung with a large sag between poles, and these conductors take nearly fixed positions in planes at angles with the vertical in a strong wind, but cause little or no vibration of their supports. One reason for the greater sag of the aluminium over that of the copper conductors in this case is the fact that the poles carrying the former are 140 feet apart while the distance between the poles for the latter is only 70 feet, on straight sections of the lines.

The necessity for greater sag in aluminium than in copper conductors, even where the span lengths are equal, arises from the greater coefficient of expansion possessed by the former metal. Between 32 and 212 degrees Fahrenheit aluminium expands about 0.0022, and copper 0.0016 of its length, so that the change in length is 40 per cent. greater in the former than in the latter metal. The conductors in any case must have enough sag between poles to provide for contraction in the coldest weather, and it follows that the necessary sag of aluminium wires will be greater than that of copper at ordinary temperature.

In pure air aluminium is even more free from oxidation than copper, but where exposed to the fumes of chemical works, to chlorine compounds, or to fatty acids, the metal is rapidly attacked. For this reason aluminium conductors should have a waterproof covering where exposed to any of these chemicals. The aluminium line between Niagara Falls and Buffalo is bare for most of its length, but in the vicinity of the large chemical works at the former place the wires are covered with a braid treated with asphaltum. Aluminium alloyed with sodium, its most common impurity, is quickly corroded in moist air and should be carefully avoided. All of the properties of aluminium here mentioned relate to the pure metal unless otherwise stated, and its alloys should not, as a rule, be considered for transmission lines. As aluminium is electropositive to most other metals the soldering of its joints is quite sure to result in electrolytic corrosion unless the joints are thoroughly protected from moisture, a result that is hard to attain with bare wires. The better practice is to avoid the use of solder and rely on mechanical joints. A good joint may be made by slipping the roughened ends of wires to be connected through an

aluminium tube of oval section, so that one wire sticks out at each end, then twisting the tube and wires and giving each of the latter a turn about the other. Aluminium may be welded electrically and also by hammering at a certain temperature, but these processes are not convenient for line construction. Especial care is necessary to avoid scarring or cutting into aluminium wires, as may be done when they are tied to their insulators. Aluminium tie wires should be used exclusively. To avoid the greater danger of damage to solid wires and also to obtain greater strength and flexibility, aluminium conductors are most frequently used in the form of cables. The sizes of wires that go to make up these cables commonly range from number 6 to 9 B & S gauge for widely different cable sections. Thus the 183,708 circular mil aluminium cable between Shawinigan Falls and Montreal is made up of seven number 6 wires, and the 471,034 circular mil cable between Electra and Mission San Jose contains thirty-seven number 9 wires. From the Farmington River to Hartford each 336,420 circular mil cable has exceptionally large strands of approximately number 3 wire. It appears from the description of a 43-mile line in California, Vol. XVII, A. I. E. E., page 345, that a solid aluminium wire of 294 mils diameter, or number 1 B & S gauge, can be used without trouble from breaks, and the same is probably true for even larger sizes. This wire was fully tested by Dr. A. E. Kennelly and its properties reported as follows:

Diameter, 293.9 mils.
Pounds per mile, 419.4.
Resistance per mil foot, 17.6 ohms at 25° C.
Resistance per mile at 25° C., 1.00773 ohms.
Conductivity as to copper of same size, 59.9 per cent.
Number of twists in six inches for fracture, 17.9.
Tensile strength per square inch, 32,898 pounds.

This wire also stood the test of wrapping six times about its own diameter, and then unwrapping and wrapping again. It was found in tests for tensile strength that the wire in question took a permanent set at very small loads, but that at points between 14,000 and 17,000 pounds per square inch the permanent set began to increase very rapidly. From this it appears that aluminium wires and cables should be given enough sag between poles so that in the coldest weather the strains on them shall not exceed about 15,000 pounds per square inch. This rather low safe working load is a disadvantage that aluminium shares with copper. From the figures just given it is evident that the strains on aluminium conductors during their erection should not exceed one-half of the ultimate strength in any case, lest their sectional areas be reduced.

ALUMINIUM CABLES IN TRANSMISSION SYSTEMS.

Locations.	Number of cables.	Miles of each.	Circular mils of each.	Strands per cable.	Size of strands. B. & S. G. Approximate.
Niagara Falls to Buffalo.....	3	20	500,000	..	..
Shawinigan Falls to Montreal..	3	85	183,708	7	6
Electra to Mission San Jose..	3	100	471,034	37	9
Colgate to Oakland	3	144	211,000	7	5-6
Farmington River to Hartford.	3	11	336,420	7	3
Lewiston, Me.	3	3.5	144,688	7	8
Ludlow, Mass.	6	4.5	135,247	7	7

This table of transmission systems using aluminium conductors is far from exhaustive. Aluminium is also being used to distribute energy to the sub-stations of long electric railways, as on the Aurora and Chicago which connects cities about forty miles apart. The lower cost of aluminium conductors is also leading to their adoption instead of copper in city distribution of light and power. Thus at Manchester, New Hampshire, the local electric lines include about four miles each of 500,000 and 750,000 circular mil aluminium cable with weatherproof insulation. The larger of these cables contains thirty-seven strands of about number 7 wire.

As may be seen from the foregoing facts, the choice of copper or aluminium for a transmission line should turn mainly on the cost of conductors of the required length and resistance in each metal. So nearly balanced are the mechanical and chemical properties of the two metals that not more than a very small premium should be paid for the privilege of using copper. As already pointed out, the costs of aluminium and copper conductors of given length and resistance are equal when the price per pound of aluminium wire is twice that of copper. During most of the time for several years the price of aluminium has been well below double the copper figures, and the advantage has been with aluminium conductors. With the two metals at the same price per pound aluminium would cost only one-half as much as equivalent copper conductors. When the price of aluminium is 50 per cent. greater per pound than that of copper, the use of the former metal effects a saving of 25 per cent. For the new Niagara and Buffalo line, completed early in 1901, aluminium was selected because it effected a saving of about 12 per cent. over the cost of copper. All of the aluminium lines here mentioned, except the short one near Hartford, were completed during or since 1900. Most of the facts here stated as to the

line between Niagara Falls and Buffalo are drawn from Vol. XVIII, A. I. E. E., at pages 520 and 521.

The greater diameter of aluminium over equivalent copper conductors has advantages in transmission with alternating current or at very high voltages. Inductance, by which the necessary voltage at alternating stations for a given effective line voltage is increased, varies inversely in amount with the diameter of the conductors employed, other factors remaining the same. The amount of inductance in any case is thus less with aluminium than with equivalent copper conductors. At high voltages, say of 40,000 or more, the constant silent loss of energy from one conductor to another of the same circuit through the air tends to become large and even prohibitive in amount. This loss is greater, other factors being constant, the smaller the diameter of the conductors in the line. It follows that this loss is more serious the smaller the power to be transmitted, because the smaller the diameter of the line wires. The silent passage of energy from wire to wire increases directly with the length of line and thus operates as a limit to long transmissions. Aluminium conductors, having larger diameters for any given length and resistance than those of copper, extend the radius of transmission for large powers and increase the number of practicable transmissions of smaller powers.

A PROJECT FOR A CAPITALIZED LABOR ORGANIZATION.

By Casper L. Redfield.

The problem of adjusting the interests of employers and employees on some practical working basis is one which may well occupy the present attention of the ablest minds. Conventional institutions seem to be unequal to it, and unconventional thought is cordially welcome. Mr. Redfield's scheme is probably bristling with difficulties—some of them, indeed, he recognizes so frankly as to leave them for the present without even an attempt at discussion. Such, for example, is the initial underwriting of the scheme. Another example might be the fulfillment of the guarantee of dividends. It is even questionable whether any practicable capitalization could secure a sufficiently substantial interest in a sufficient number of concerns to exercise a material influence on their labor relations. The idea is submitted by the editors, as, we take it, it is by the author—as a suggestion along unhackneyed lines. Comment and criticism are not only permissible; they are earnestly invited.—THE EDITORS.

IT has often been said that the interests of capital and labor are identical, but a record of the labor situation at any time is evidence that this identity of interest is not sufficient to prevent conflicts which are costly alike to employer and employee. The fact is, there are conflicting interests as well as identical interests, and the conflicts between capital and labor come from these conflicting interests. Work is healthy, but the workman does not work for his health any more than the capitalist goes into business for his health. Each is after as large a portion as possible of that thing which is the product of the united efforts of capital and labor, and the trouble lies in the division of the spoils.

The mediæval idea of acquiring riches was for one body of men to attack and rob a neighboring body, but one of the lessons of modern civilization is that men with conflicting interests can make more profit by business transactions than they can by warfare. If the man on the south side cannot complete a business deal with the man on the north side, he does not waste his energies in quarreling. He utilizes these energies in carrying out a deal with the man on the east side and with the man on the west side, and at a later date he finds that his forbearance has enabled him to consummate a profitable transaction with the north-side man. This is business.

Today the relationship between capital and labor is a survival of the mediæval idea of loot. If a business relationship is to be sub-

stituted for this policy of piracy and plunder, then the initiative must be taken by the business man and not by the dreamer. The man who knows must help, must guide, and must instruct the man who does not know.

The workingman feels that in any business transaction the trained business man is the shrewder individual of the two; hence the workingman looks with suspicion upon any proposition the aim of which is to tie him to his employer by making him a small stockholder in his employer's business. He strenuously objects to being caught in an embarrassing contract as the result of swallowing a pitifully small bait. It is therefore evident that if the capitalist is to establish with the laborer the only kind of a relationship which can be profitable to both, he must not only be perfectly fair but he must remove from his proposition every suspicion of a trap.

The plan of selling or of giving small blocks of stock to employees and the plan of profit sharing are palliative, not curative measures. At best they are only local in their application. Socialism is a dream which will not be accepted by energetic and enterprising men, and which, if put in force, would be destructive of that individual initiative which is the precursor of progress.

It often happens that of many things proposed no one is effective, but that a proper combination of these various things will accomplish the desired result. The object of this article is to bring together several scattered elements in the form of a proposition intended to create a business relationship, not between individual employers and their employees, but between capital as a whole and labor as a whole. This proposition takes the form of a capitalized labor organization, the main object of which is for the organization as an organization to own good-sized blocks of stock in corporations employing labor of the kind which constitutes the organization. Without further preliminary we will plunge directly into the proposed form of organization and afterwards discuss some of the matters relating to it.

As an example of an organization which is not the easiest nor the most difficult to form, let us assume a Machinists' Corporation with a capital stock of $10,000,000 divided into shares of $10 each. For the purpose of keeping the stock widely distributed and the number of stockholders large, we will assume the limit of holdings of any one person to be $1,000. Besides owning stock in manufactories employing machinists, the objects of the corporation are to be securing employment for its members on the best terms obtainable, and the promotion of the general welfare of machinists. For the purpose of keep-

ing such an organization in a line in which it will be of value to both capital and labor certain rules or by-laws will be required, of which the following are examples:—

1—The corporation will take no part in any labor dispute.

2—Membership in any labor organization shall in no way affect any one's rights to become a stockholder in this corporation.

3—No stock shall be sold to any person other than those engaged in making, using, or selling machine tools.

4—No transfer of stock from one person to another shall be recognized.

5—The corporation will at all times, and on demand, redeem stock at par.

6—All stockholders are guaranteed annual dividends of not less than 6 per cent.

7—A bureau of employment will be formed and offices maintained at suitable places.

8—Stockholders will be charged a nominal fee for each situation secured for them, and other machinists will be charged a slightly higher fee for the same service.

9—The officers of the corporation shall, from time to time and by instructions of the board of directors, use the money accumulating in the treasury from the sale of stock of the corporation to purchase stock in manufactories using machine tools.

10—The secretary shall promptly notify all stockholders of each purchase made.

It will be observed that there is not only a guarantee of a 6 per cent dividend, but the corporation also agrees to redeem its own stock on demand. As there are also certain expenses to be met, it will be evident that before such a corporation can be formed there must be a supply of money on hand. We will assume for the present that some genie has furnished it, and that there is a fund which may be drawn upon for all legitimate expenses until the corporation has an income of its own sufficient for the purpose of meeting its running expenses and providing the guaranteed dividend.

With the corporation formed and a guarantee fund on hand, machinists are invited to purchase stock. When the prospective stockholder learns that he has something to gain and nothing to lose, that his liberty is not curtailed in any way, and that he can back out at any time without loss, he will not be slow to enter into such an arrangement to the limit of his financial ability. There are several immediate advantages to him and a number of prospective ones that will appear under

a successful management of the corporation. Among the immediate advantages to the workman may be noted the following:

He has a safe place for his money and he can get it at any time; he is in a powerful organization of his fellows and does not have the feeling like that of a cat in a strange garret which comes from being a small stockholder among big stockholders; and he has improved opportunities of obtaining a situation should he lose the one he has.

In due course of time our prospective corporation has 10,000 stockholders, has purchased $200,000 of the capital stock of dividend-paying manufacturing companies, and has notified all of its stockholders of the extent and kind of these purchases. Among the purchases made would be an interest in the Smith Co., manufacturers of lathes and planers; an interest in the Jones Co., manufacturers of milling machines and drill presses; and an interest in the Brown Co., manufacturers of machinists' small tools. As these 10,000 machinists buy a good many small tools for their own use and as they have a financial interest in the dividends of the Brown Co., they will buy the Brown tools in preference to other tools. While the influence of one machinist is small the influence of 10,000 machinists is great, and all of these 10,000 machinists favor the Smith machines and the Jones machines. As a consequence of this the sales of these machines increase at the expense of the sales of the machines of their competitors. The Smith Co., the Jones Co., and the Brown Co. not only reap all the advantages that they would have by getting their own employees to own part of their stock, but they reap the additional advantages of widespread influence.

Under these conditions it will not be long before the Johnson Co. and the Jackson Co. realize the importance of having the Machinists' Corporation own part of their stock, and they will offer it at a discount from market value. In fact, as a business proposition, it will pay the Johnson Co. and the Jackson Co. to donate large blocks of stock and charge the expense to advertising and to improvements. The value received from this form of investment would be greater than from a similar sum of money invested in almost any other way.

Many employers are finding it to their advantage to sell or even to give stock to their employees. Stock tranferred to a corporation of employees would have all the effects that could be obtained by the same stock transfered to individual employees, and in addition thereto would have many other effects. Besides the advertising features there would be only one man to deal with—the representative of the corporation, the titular stockholder. The individual employees not being

direct stockholders would not and could not seek to interfere with the management of the business. In case of labor troubles originating elsewhere there would be less pressure brought upon the employees of a company which has transferred part of its stock to a corporation in which all of the working men were interested. By common consent such a company would be exempt from strikes that would menace the prosperity of rival concerns. This common consent would arise from the fact that a very great number of workmen would be deriving a benefit from the dividend-paying power of this company. Even in the case of dissatisfaction among the employees of such a company, there would be strong influence among other workmen to have the dispute settled amicably.

With all these advantages accruing to a manufacturer by reason of part of the stock of his company being held by the employee corporation, it would not be long before the corporation would hold dividend-paying stock of a value much above the actual amount of cash involved. As a consequence the income of the corporation would soon exceed the sum necessary to pay all expenses and give 6 per cent to its stockholders. When this time came the machinist would realize some of the prospective benefits that he did not perceive at the time he first purchased stock in the corporation. He would find that he had not only saved some of the money which he would otherwise have squandered, but that this saving was bringing him an income he would not have received but for his purchase. He would find that the regularity of his employment was not so often interrupted by strikes, and hence, that the total wages earned would be greater. He would find that employers would give him a preference, both in employment and in amount of wages, over employees not interested in such a corporation. He would feel that although his actual interest in any particular manufacturing concern was very small yet he and his associates, though their representative—the titular stockholder—exerted a powerful influence by reason of the large block of stock held and the corresponding vote at the stockholders' meetings.

It is not the intention to indicate all of the preliminaries to the formation of such a corporation, nor all of the consequences arising from its organization. The real point is, can such a corporation be formed and carried to a successful issue? If it can be formed and made successful will it tend to eliminate or even to diminish labor troubles? I believe that these questions should be answered in the affirmative. The real answer, however, will depend upon the good sense and the fairness of the promoters. That these promoters must

be business men acting in conjunction with some person or persons known to be friendly to labor, and that these business men must furnish the fund necessary to meet preliminary expenses and the guarantees relating to stock and dividends, goes without saying. If they do furnish such a fund and promote an organization which will be financially profitable to workingmen without restricting their freedom in any way, then there is no doubt but workingmen will join it in large numbers. The first persons to be attracted to such an organization would be the best workingmen, those independent and enterprising individuals who refuse to be dictated to by labor unions. To these would soon be added those persons who now join labor unions only from a matter of policy.

With such a corporation formed, the stockholders would elect their board of directors in the regular order, and the directors would elect the officers. These officers would be the only persons with whom the manufacturers would have any dealings in regard to the management of business, and each manufacturer would meet one of these men on exactly the same grounds that he would meet any other large stockholder. Furthermore, this titular stockholder would have no more to say about the employment of labor than would any other stockholder. The relationship should be a strictly business one. The mere fact that the actual owners of this stock were certain workingmen would of itself create a preference for these men, but an effort to use the influence of the corporation in favor of certain men would be a departure from business principles and would tend to defeat its own object.

But the crux of the whole matter is, will such corporations organized in different lines of manufacture reduce the friction between capital and labor and thus tend to prevent strikes and lock-outs? If they will do this then capitalists can afford to endow such corporations with vast sums, but if they will not do this then capitalists can not afford to give anything in this way.

Perhaps the best way to arrive at a conclusion in this matter is to consider the actions of men in the event of a labor trouble between a manufacturing concern which has sold part of its stock to a labor corporation, and the employees who are stockholders in this same corporation. While this corporation as a corporation is bound by its constitution to take no part in such a dispute and cannot intervene between employer and employee, it is in a position to exert strong influence in favor of arbitration. The corporation owns stock in the company and, through its titular stockholder, is in touch with the officers of the company. It is also in touch with the workmen because they are stock-

holders in the corporation. Under such conditions as these an arbitration, formal or informal, would be forced, and some of the officers of the corporation would probably be agreed upon as arbitrators. Now these arbitrators will be in a peculiar position. If they decide against the company in such a way as to injure its money-making capacity, then they are cutting off part of the dividends of the corporation and causing a corresponding injury to fall upon all of its stockholders. If they decide against the employees in such a way as to reduce wages to something less than what similar employees receive elsewhere, then they are injuring part of the stockholders in the corporation and are laying up untold troubles for themselves in the future. If they must decide such a controversy they will be eminently fair, but the probabilities are that they would use their influence to prevent a controversy of any kind. They would urge the men to make terms as individuals and not as an organization. If there were individuals who were dissatisfied with the terms that could be made in this way, then these officers would exert themselves to find satisfactory situations for these persons at other places.

It is only by some such process as this that these officers could keep themselves out of trouble and at the same time make money for the stockholders of the corporation. In other words, these officers would learn that business methods are superior to warfare, and the working men would, through their pocketbooks, learn the same thing. When they do learn this then we may have industrial peace through the substitution of business methods for the present confusion.

EDITORIAL COMMENT

THE development of the modern Cup racer, so well reviewed by Mr. Stephens in this number, affords one of the most interesting examples of the replacement of empirical by engineering methods, and not the least striking point illustrated is the manifest exactness of engineering as an applied science. Twenty years ago, when the "boat-builder" was supreme in the design of the contestants, the types produced in England and on this side were almost as far apart as they could be. It was "cutter" against "skimming dish." Every move since then has given the engineer, in some branch of the profession, a larger part in the production of the "90-footer," and every move has brought each new construction nearer to a definite ideal, until the challenger and defender of today show lines which only an expert could distinguish one from another.

A very good comprehensive summary of the structural changes which have attended this movement is afforded by a set of outline specifications prepared by Mr. Stephens, in further illustration of the points made in his paper. "The centerboard Cup defender of 1885," writes Mr. Stephens, "had keel, stem, and sternpost of oak, frames double sawn, of oak, planking of oak below and yellow pine above water, about 2½ inches thick, shelf of oak, clamps, bilge stringers and ceiling of yellow pine. The hull was braced by knees of oak and hackmatack. The deck was white pine, 2¼ inches thick, on oak deck beams. All spars were of Oregon pine or spruce, solid.

"The steel yacht of 1885 to 1893 had frames of steel angles, spaced about 21 inches on centers, and extending from the bottom of the keel to the deck. Her plating was steel, laid 'in-and-out'; the bottom plate of the keel with the garboards formed the ballast tank, into which molten lead was poured. Deck and floor beams were of steel angles, tied to the frames with gusset plates; there were one or two longitudinal stringers of steel angles on each side.

"The modern 90-foot Cup defender has a lead keel, first cast in a single piece, the keel plate, a bronze casting, being fastened on top of the keel by bronze lag screws. The garboards, bronze plates, lap about 18 inches on the keel, being fastened to it by several hundred bronze screws of large size. The principal members of the hull are the web frames, spaced 6 feet 8 inches on centers; these are thin steel plates, from 8 to 20 inches wide, the inner edges stiffened by light bulb angles. Similar angles join the webs and the outer plating. In connection with these web frames are numerous longitudinal stringers, T beams at each joint of the plates, and bulb angles in the center of each plate. The plates are all of bronze, laid flush, the adjoining edges riveted to the head of a T bar. The usual angle frames are introduced at 20 inch intervals, three between each pair of web frames, extending from the keel plate only up to the lowest longitudinal, merely strengthening the fin and its connection with the main portion of the hull. The deck plating is of thin steel or aluminum, carried on the webs and a system of

diagonal straps, and covered with canvas. The entire interior of the hull, in particular about the foot of the mast, is braced by numerous struts and ties of steel tubing. The mast, boom and gaff are hollow, built of nickel-steel plates; the bowsprit is solid, of Oregon pine, the topsail yards and spinnaker boom of spruce or pine, hollow."

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A SCIENCE may be never so exact, and yet be ill-applied. Wisdom is not always justified of her children. New York has had to apply to the building of her subway, as she did but a short time ago to the operation of her elevated roads, the coercive power of public common sense as a remedy and corrective for ill-administered engineering. She has herself partly to blame for encouraging the temper which made possible the conditions of the past three years. Abuse of the streets by one "interest" to the vast prejudice and discomfort of much wider interests —by shops and warehouses to the prejudice of pedestrians, by truckmen to the prejudice of the entire traffic of the city, by builders to the prejudice not only of traffic but of all neighboring property—this has been the rule and the custom. It is hardly surprising that the most colossal construction New York has attempted should have been characterized by the most colossal brutality to the by-standing interests. It *is* surprising and melancholy that the brutality should have been permitted—almost invited—by those whose position gave them the power and imposed on them the duty to see that a better way was followed. In no other city of the world could such conditions exist as have disgraced New York for months past—but in what other city would the serious, matter-of-fact proposal to "cut and cover" an avenue like Broadway be seriously considered, so long as any other practicable plan for the work as a whole existed?

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WE have referred elsewhere in this issue to the retirement of Rear-Admiral Melville and to his career in connection with the Bureau of Steam Engineering of the United States navy, but his work in the broader domain of engineering at large demands notice here as well. Apart from his inspiring personality and the enthusiasm which the Admiral has invariably communicated to his associates and subordinates, his method of work may be cited as an excellent instance of the element which makes an engineer at the same time an able administrator. Many men have developed large engineering ability; others have shown the faculty of administration; and still others have been gifted with powers of research and the development of new ideas. It is unusual, however, to find these different capacities united in the same individual, and still more unusual to see such an individual placed in high official position.

In most countries the value of experience gained by years of active service is found to be sufficient reason for the retention of valuable officers in the active list, but the present rules in force in the American navy unfortunately compel the retirement of men of high ability just at the period when they may naturally be expected to be at the height of their powers. That such a method gives opportunity for the promotion of officers of lower grade cannot be denied, but it hardly seems as if this fact were a sufficient offset to the nation's loss in the retirement of such men as Melville.

* * *

WHILE the wisdom of the policy of the United States goverment in wilfully depriving itself of the services of one of the ablest of its officers may well be

questioned, occasion may at least be found to commend the practice which has enabled Admiral Melville to perform one of his greatest services to the engineering profession. In no other service in the world is such freedom as to publicity of methods and plans permitted as in that of the United States. The annual reports of the Chief of the Bureau of Steam Engineering have long been recognised as among the important engineering publications of the year. They have formed the subject of extended reviews and editorials in the technical press of London, Paris, Berlin, and Vienna, and they have placed the professional status of that Bureau in the forefront of engineering progress. Details which in other lands would have been jealously guarded under the seal of official secrecy, and the revelation of which would have created international scandals, have been permitted to be published and discussed as freely as are the professional papers of a technical society. While some have questioned the wisdom of such a liberal policy, there is absolutely no doubt in the minds of engineers that it is the only correct method to pursue. When the work of a government bureau is placed before the entire profession for scrutiny and comment there is ample assurance that that work will be of the highest grade which can be had, or that it will at once receive the adverse comment which it deserves. That the reports of Admiral Melville have been received as permanent additions to the standard literature of marine and naval engineering is sufficient evidence of the merits of his work, and ample confirmation of the wisdom of the policy of publicity which has obtained.

* * *

THE advocates of secrecy in government work doubtless hold their position because of the theory that rival nations may benefit by the information which may be permitted to become public. The fallacy of any such notion must be apparent to any one who examines the question in the light of practical experience. Parallel instances may be found among those few private establishments which decline to admit visitors, and which hedge all their operations about with a wall of mystery and exclusiveness. It is well known that such works are generally far behind those of more liberal methods, and visitors who have succeeded in penetrating behind the veil almost invariably report that the most obvious reason for the secrecy is the fact that there is nothing of value to show. The same condition undoubtedly exists in the technical departments of governments which hold to the antiquated theory of mysterious secrecy. If the truth were known they have little to show, and what there may be of merit or originality in their work is promptly made known by private channels to all who are sufficiently interested. When, through the medium of freely published reports, such as are given to the world through the various bureaus of the United States government, some fair measure of the activity and effectiveness of the work is made known, the citizens are assured of the character of the service which they as a nation are receiving, while rival governments are fully apprised of the readiness of the preparations which are being made. The policy of secrecy is that of the ostrich, burying its head in the sand, while the method of publicity is that of the self-reliant antagonist, confidently exhibiting the the strength of his weapons.

* * *

LAST March comment was made in these columns upon the important question of the erection of a general building for the housing of the libraries and offices of the national engineering societies, and a suggestion was made

that it might be possible to organize a realty-holding association which could provide such a structure without any apprehensions as to undue predominance of any of the societies in the work. Since that time the remarkable offer of Mr. Andrew Carnegie to provide a million dollars for the erection of such a building has been made public, and the success of the plan is wholly assured.

Of the great value of this munificent gift to the engineering profession nothing can be said which is not at once suggested to every one. It must facilitate to a remarkable degree the work of all the associations who are so favored as to be admitted to partake in it, and it cannot fail to stimulate activity and development in every line of engineering work.

Of the five bodies which have been invited to accept the benefits of Mr. Carnegie's offer four have already signified their acceptance and appreciation. The fifth is doubtless hesitating only because of the fact that it has so recently expended a large sum in the erection of an extensive and beautiful house of its own. The Engineer's Club had already under consideration the building of a new house, the American Society of Mechanical Engineers owns a house which it has already outgrown, and which in the course of municipal improvement must soon be considered unsuitable, while the American Institute of Mining Engineers and the American Institute of Electrical Engineers, being without houses of their own, were free from any hampering considerations. That the possession of their present handsome building can deter the American Society of Civil Engineers from partaking in the acceptance of Mr. Carnegie's gift we can hardly believe. As we have already written: "Engineers are notably men of change, and there is no great railway company, for example, which would hesitate to tear down and remodel or remove a newly-built terminal if sufficient advantage could be shown, and no engineer but would advise such action if consulted about it."

It has been intimated that the American Society of Civil Engineers hesitates to join in the occupation of a building with the other national societies because of an unwillingness to co-operate with the later organizations, but such a disposition, if it exists, must be that of individuals only, and we are unwilling to think that it can be the sentiment of the membership at large. The plan involves absolutely no change in the policy or methods of administration of any of the societies, and the question as to the reality of the division of the profession into the departments of work indicated by the names of the four national associations is one of fact and not of opinion or sentiment. If, before the organization of any of the later societies, the American Society of Civil Engineers had taken steps to include all branches of the engineering profession in its ranks, it might well have held that "civil engineering" included all engineering not military, and it is probable that the younger societies would never have been organized; but having failed to rise to the situation at a time when such a broad scope might have been realized, it is now too late, and the field must remain divided. It is greatly to be hoped that an overwhelming majority of the membership of the American Society of Civil Engineers will accept the situation as it actually exists, and continue to advance the work of the profession which it has done so much to adorn in the past.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

STEAM ENGINEERING IN THE UNITED STATES NAVY.

THE WORK OF REAR-ADMIRAL MELVILLE, ENGINEER-IN-CHIEF, AND THE BUREAU OF STEAM ENGINEERING.

W. M. McFarland—Engineering News.

WITH the retirement of Rear Admiral Melville as Engineer-in-Chief of the United States Navy there comes the opportunity to review and comment upon the effective work which he has done for the development of marine and naval engineering during the past sixteen years, and this opportunity has been well seized by Mr. Walter M. McFarland in a recent issue of *Engineering News*. In reviewing Mr. McFarland's paper we also take great pleasure in noting incidents of our own experience in the course of a long friendship with the man who has done so much for the development and equipment of the service and for the engineering profession all over the world.

Rear Admiral Melville was appointed Engineer-in-Chief of the United States Navy in August, 1887, this placing him at the head of the Bureau of Steam Engineering, the appointment being made as a direct consequence of his high reputation as one of the most skilful engineers in the navy, as well as because of his magnificent record in the Arctic cruise of the Jeannette, where he had command of the only one of the boats whose crew was finally saved. The combination of engineering skill and tremendous executive ability thus exhibited pointed him out as emphatically the man to lead in the development of the engineering work of the new navy, and Secretary Whitney promptly grasped the opportunity with a wisdom fully justified by the sequence of events.

When Admiral Melville came into office the four cruisers built by John Roach, the beginning of the modern navy which was to supersede the obsolete vessels of the day, were in commission, and contracts had been placed for a few of the succeeding vessels. With these exceptions, however, all of the machinery of the vessels of the United States navy as it is to-day, has been designed and built under Admiral Melville's supervision and responsibility. The magnitude of this task may be appreciated when it is understood that it is represented by about one million horse power of steam engines, with all the immense mass of auxiliary machinery and appliances necessarily included.

This is not the place, nor indeed is space available to enumerate even the salient features of Admiral Melville's administration of the Bureau of Steam Engineering. For such information the interested engineer must be referred to that remarkable series of annual reports which have been issued by the Engineer-in-Chief during the past sixteen years. Public documents are usually dreary reading, and it is not the least of Admiral Melville's successes that his reports have been most eagerly awaited and widely discussed. This has been especially the case in other countries than the United States, since the policy of secrecy and reticence so common in most European countries is entirely absent in the American Bureau, where the latest results of government experiments and methods are freely given to the public to the great benefit of the profession at large, and, it is fully believed, to the advantage of the naval service as well.

When it is remembered that during Admiral Melville's administration he has been among the first to advocate the use of water-tube boilers for naval purposes, to develop the application of triple screws for the propulsion of fast cruisers, to urge the higher powering of battle ships, and to apply oil fuel to naval purposes, it will be seen that these reports contain a wealth of information and data not to be found elsewhere.

Mr. McFarland lays especial stress upon the persistent and effective work done by Admiral Melville, in connection with the long fight of the engineers in the United States navy for recognition of their official status. It was undoubtedly due in great measure to the personal efforts of Admiral Melville and the encouragement which he gave to other members of the Engineer Corps in the struggle that the Personnel Board was appointed by Secretary Long. This board, presided over by President Roosevelt, then Assistant Secretary of the Navy, effected a complete reorganization of the entire personnel of the navy, the engineers being consolidated with the line officers, making them executive officers, the ultimate object being to make all future naval officers primarily engineers. The recent plan of the First Lord of the Admiralty for the reorganization of the personnel of the Royal navy, while necessarily modified in detail, may undoubtedly be considered as a natural sequence of the work of the Personnel Board of the American navy. Since the action of the Navy Department in thus reorganizing the personnel, Admiral Melville has always been a consistent advocate of the enactment of satisfactory methods for enforcing the provisions of the law, these being all that is lacking for the prompt realization of the full advantages of that most important enactment.

Much of Admiral Melville's success in the administration of the Bureau of Steam Engineering has been due to his inspiring personality. Few men have the faculty of arousing in their associates and subordinates the enthusiasm which they themselves may feel in their convictions and in their ideals. Admiral Melville has always attracted to himself men capable of appreciating his plans and his work and in filling them with his own enthusiasm, and the result has been a Bureau with an *esprit de corps* almost unequalled in the annals of national affairs. To have been associated with him in any capacity was not only a liberal education in executive work, but also a mental stimulus as powerful as rare. This influence extended far beyond the limits of his official relations, and in the engineering profession in all parts of the world his striking personality has made itself felt.

Apart from the work in the naval service, work which might well be supposed to occupy all the time of even such a worker as Melville, we find numerous contributions from his powerful pen in the transactions of engineering societies and in the pages of the technical press. Thus he acted most ably as the President of the Naval Engineering Congress at the World's Fair in Chicago, in 1893. In 1898 he was unanimously elected to the high office of president of the American Society of Mechanical Engineers, while his contributions to the proceedings of the American Socitey of Naval Engineers, the society of Naval Architects and Marine Engineers, the Institution of Naval Architects, and other bodies, form a notable list. Especially may be noted his recent exhaustive paper upon the subject of the vibration of steamships and the extent to which they may be removed by balancing, this having been published in *Engineering*, and reviewed at length in these columns a few months ago.

An interesting example of the determined and effective manner in which Admiral Melville pursues a question, undeterred by the hampering influences of officialdom, is seen in the matter of the speed of the proposed 13,000-ton battle ships of the United States navy.

The designs submitted by the Board on Construction, of which Admiral Melville was a member, proposed the construction of a 13,000-ton battle ship with an armament about equal to that of a 16,000-ton vessel, together with a speed of only 16 knots. Although this report was accompanied by a strong protest on the part of Admiral Melville, together with a specific statement of his objections to the design, it received the approval of the Secretary of the Navy, inasmuch as it had the signatures of a majority of the board. Now, however, the

subject has been reviewed by a communication to the Secretary by Rear-Admiral Bradford, another member of the board, protesting against the construction of such ill-proportioned vessels. Admiral Bradford's letter bears an endorsement by Admiral Melville, emphasizing the defects in the proposed designs, and the result of this action will probably be the prevention of the commission of an enormous blunder. There is little doubt that the proposed armament would be far too heavy for the vessels, both as regards space and crowding and also in respect of excessive strains due to the high pressures and muzzle-velocities of modern ordnance. Considering a battle ship as a "fighting-machine" Admiral Melville says: "It is my belief, founded upon special consideration of the subject, that the fighting value of the ship would be greatly improved and her endurance increased by giving greater speed and increasing the radius of action. The actual fighting value of the ship, even after reaching the battle line, would not be reduced by lightening armamant, for with the battery contemplated there is no doubt that continued trouble will be experienced with the gun mounts and emplacements."

Thus it will be seen that Admiral Melville's latest expression of opinion, together with the great weight which attaches to his words, may result in saving the Department from making a great blunder, and correct an important error before it is too late.

In connection with the retirement of Admiral Melville, because of his attainment of the age-limit of sixty-two years, we can only endorse the words of Mr. McFarland: "It is a great misfortune that the rule should deprive the government of his services, but inasmuch as it has recently become customary to call on retired officers of such great ability as his for special services, we have no doubt that the government will not lose the benefit of his talents."

DISINFECTION BY THE USE OF STEAM.

ADVANTAGES AND DISADVANTAGES OF SUPERHEATED STEAM FOR DISINFECTION AND STERILIZATION OF CLOTHING AND OTHER MATERIALS.

Drs. Kister & Weichardt—Gesundheits-Ingenieur.

IN the course of the increasing scope of the work of the engineer many things formerly assumed to be entirely without his domain have come into its limits. Among these may be noted the employment of steam, either saturated or superheated, for the purpose of destroying disease germs in materials supposed to be infected and yet of sufficient value to be worth saving. Thus the wholesale destruction of clothing, bedding, blankets, and similar articles which have been exposed to possible infection, might work great hardship or loss to the owners, and while the public welfare will not permit mistaken leniency, a harmless yet effective system of sterilization becomes most important. The recent affair concerning infected army blankets which were conveyed from South Africa to England to the great risk of public health, is an example of the necessity for a simple, effective, and convenient method of sterilization and disinfection applicable to such cases.

The use of steam for purposes of disinfection is by no means new, but the conditions under which it may be most effectively employed are so well set forth in a paper in a recent issue of the *Gesundheits-Ingenieur*, by Drs. Kister and Weichardt, of the Government Hygienic Institute at Hamburg, that some abstract and review of it is here given.

The serious use of steam for purposes of disinfection may be credited to Koch, whose researches in 1881 demonstrated that a current of saturated steam was a simple, effective, and economical method of destroying the germs of disease. These experiments showed that germs which required three hours' exposure to dry air at a temperature of 140° C. for their destruction, were effectually killed in 10 minutes in a current of saturated steam Later experiments by Von Esmarch have proved that a full exposure of 10 to 12 minutes to the action of steam at atmospheric pressure is sufficient to destroy all but the most resistent germs, only certain saprophytes requiring a longer exposure,

and all germs of infectious diseases being killed by the shorter exposure.

Under these circumstances the use of steam for purposes of disinfection demands serious attention. Since nearly all the scientific experiments have been made upon a laboratory scale only, it is important that the constructive and operative details of the method when applied upon a large scale should be considered, and it is here that the work of the engineer joins the investigations of the physician and the biologist. Thus many of the articles to be disinfected are of large size, such as mattresses, bedding, and the like, and the economy of the method depends to a great extent upon the ability to treat large quantities of material effectively at one time, so that a large chamber, to all parts of which the steam shall have free and complete access, is essential in practice. Since many materials would suffer injury by subjection to moisture, it has been found desirable to give the articles a preliminary heating by some dry method in order to prevent excessive condensation, while a subsequent warming and drying is sometimes also desirable. It is only natural that under these conditions the use of dry, superheated steam should have been suggested, and, under the assumption that the sterilization is effected solely by the heat, superheated steam would appear to offer advantages over saturated steam for the purpose in view. The investigations of Von Esmarch, however, have demonstrated that super heated steam is not so effective as saturated steam, and upon examination the reasons for this apparent anomaly will be apparent.

While it is true that the destruction of the germs is caused by the heat, the effectiveness of the operation is largely dependent upon the thoroughness with which the steam is brought into contact with every part of the infected material. The penetration of the steam into the pores and between the interstices of substances and fabrics is materially assisted by the slight condensation which takes place of the steam which first enters. The entrapped air is thus gradually removed and replaced by fresh steam, while superheated steam, acting in many respects like highly heated dry air, proves less effective simply because it does not get into intimate contact with the infectious matter. The effective replacement of the air by the steam is also facilitated by the preliminary heating of the objects to be treated, since the expansion of the air drives much of it out of the spaces into which the steam should enter. When the objects to be disinfected are not injured by moisture, the most effective method is to subject them to a preliminary moistening, either by means of a spray or by a current of moist air, this insuring a condensation of the following steam in the pores, and a consequent thorough penetration of the steam. It is altogether possible that the best effect may be produced by a preliminary moistening, followed by superheated steam, the high heat of the latter being effectively introduced into the pores of the infected articles.

The general construction of the apparatus is as follows, modifications in the details being introduced in various designs. The cubic contents should be not less than 10 cubic metres (about 350 cubic feet) and so constructed that the articles to be sterilized may be arranged before being put in, preferably in an open carriage or truck. The walls of the chamber should be well insulated with some non-conducting covering in order that the heat may be well retained, and it is desirable that the steam be furnished from a special boiler in order that the conditions may be fully under control at all times. A system of heating pipes should be arranged around the walls of the chamber to permit preliminary dry heating when desired, and also subsequent drying. The admission of the direct steam varies, being arranged in some instances with simple inlet and exit pipes, and in others with long pipes perforated with small holes to insure a better distribution.

The usual procedure is to arrange the articles upon the car or traveling frame in such a manner as to permit the best possible access of the steam to the various parts. The car is then pushed into the chamber and the main door tightly closed. Suitable air doors, which must be provided, are left open during the application of the dry heat; the temperature being maintained at about 60° C. for at least half an hour, while the air circulates freely, this driving a large portion of the air

out of the pores of the articles. The air doors are then shut, and the steam turned on, entering at a little above atmospheric pressure, and flowing freely through the chamber for about 30 minutes. The steam inlet and outlet pipes should be so placed as to insure the replacement of the entire air contents of the chamber by steam, in order to obtain the complete sterilization of articles in all parts of the chamber. The direct steam may then be shut off and the air valves opened, after which the heat in the drying coils may be continued for 10 to 15 minutes before the car is withdrawn from the chamber. By having more than one car to a chamber the operation may be rendered practically continuous, and a large quantity of material rapidly and cheaply disinfected with ease and certainty.

The original paper contains much interesting information with regard to the operation of sterilizing chambers, and the extent to which various articles are penetrated by the action of saturated and superheated steam, and should be most useful to engineers who are called upon to design such apparatus.

THE ELECTRICAL CONDUCTIVITY OF FIRE STREAMS.

AN ACCOUNT OF EXPERIMENTS TO DETERMINE THE DANGER TO WHICH FIREMEN ARE EXPOSED FROM LIVE WIRES.

Friedr. Heinicke—Elektrotechnische Zeitschrift.

IN modern cities there will often be a network of overhead wires running along the streets and over houses, and conveying electrical currents having various potentials. Many of these wires are uninsulated, and contact with them may produce disagreeable, if not dangerous results, for even if the touched wire be on a low tension telephone or telegraph circuit, it may be crossed somewhere by a high-tension light or power conductor.

When fires break out, these wires often hamper the work of the firemen, for they not only offer a mechanical obstruction to the operation of the fire extinguishing apparatus, but the possibility of receiving an electric shock keeps the firemen from approaching them too closely. Of course, the electric circuit can be broken at the central station or at some junction box, or the wires can be cut down, but this takes time, and if the wires be on a lighting circuit, may plunge a quarter of the town into darkness, which is particularly undesirable when there is a fire.

One of the supposed dangers to which firemen are exposed from live wires is that when a stream of water is directed on the wires, the current may pass through the water and then through the man who holds the hose. While the possibility of such an occurrence is admitted, there has been very little definite information on the subject, and therefore some experiments made by Herr Fried. Heinicke at the Charzow central station of the Upper Silesian Electrical Works, and published in a recent number of the *Elektrotechnische Zeitschrift*, are of interest.

Herr Heinicke directed a stream of water, under a pressure of 5 atmospheres, from a nozzle of about 12 millimeters (½ inch) diameter onto a bare live conductor, very well insulated from the earth, and which was struck by the whole section of the stream. The nozzle was also insulated from the ground, and the potential between the stream of water, at its issuance from the nozzle, and earth was measured by means of an accurate voltmeter. The distance between the nozzle and the conductor was varied, and the corresponding measurements of potential were made. Two kinds of water were used; one was rather hard and a poor conductor, and was taken direct from the regular supply, while to the other was added 0.5 per cent. of pure soda.

The resistance of the hose which conveyed the water to the nozzle was found to be 5000 ohms, and the resistance of the human body, from hand to wet earth, was assumed at 15000 ohms. With these figures, and knowing the potential of the conductor and measuring the potential at the mouth of the nozzle, the respective currents flowing through the water, the hose and the body of a man holding the nozzle were calculated. It was also assumed that a man could have

a current of 0.03 ampere pass through him without injuring him.

The first set of experiments was made with a Y-connected polyphase circuit, having a voltage of 6000 between two conductors, and with a grounded neutral. The three bare copper wires had each a section of 95 square millimeters, (.15 square inch,) and were well polished. Only one of them was struck by the stream of water. The first reading was taken with the nozzle 10 centimeters distant from the wire, and at this point the potential between the stream of water and the earth was found to be 130 volts, from which it was calculated that the current passing through a man holding the nozzle would have been 0.0637 ampere. The distance was increased and at 30 centimeters (1 foot) the current through the nozzle-holder would have been only 0.0174 ampere, which could be stood with safety, though perhaps with some inconvenience. At one meter, the current would be only 0.00314 ampere, and at 125 centimeters (49 inches), no current at all would pass through the man at the nozzle. These figures were determined with the water from the regular supply mains, but when the water with 0.5 per cent. soda was used, it was found that the length of the stream had to be increased to 1 meter before a dangerous current was avoided.

A second series of experiments was made on a polyphase system with a voltage of 125, in which one phase was directly grounded. With either kind of water it was not possible to get a dangerous current, even when the distance between nozzle and conductor was reduced to 3 centimeters (1.2 inches.)

Experiments were then carried out with continuous current at 550 volts. It was only for distances of less than 8 centimeters (3.2 inches) and with the 0.5-per cent.-soda water, that a dangerous current was found. In the fourth set of experiments, with 240-volt continuous current, the distance between nozzle and wire was reduced to 5 centimeters (2 inches) without getting a current which would have endangered the man at the hose.

According to these experiments, the danger involved in playing a fire stream on live wires is not as great as has been supposed, but the quality of the water has considerable influence on the results, and experiments should be made in other places before it can be asserted that the man at the nozzle is safe from any electric currents which may by accidental causes flow through the stream.

MACHINE TOOLS FOR HIGH-SPEED STEEL.

MODIFICATIONS IN DESIGN AND POWERING TO ENABLE MAXIMUM CUTTING EFFECTS TO BE PRODUCED.

The Engineer.

IT is now generally accepted that the introduction of rapid cutting tool steels will work numerous modifications in the design and construction of the lathes and other machine tools in which they are to be used. It is not only higher speeds which must be provided, since an important element in the capacity of the new steels is the heavier cuts which can be taken. The result is that heavier and stiffer beds and frames are required, and that with the higher speeds corresponding increases in powering become necessary. These facts being accepted, it appears to be a comparatively simple matter to design acceptable tools for the modified conditions.

In a description of some improved tools made by the Tangye Tool and Electric Company, Ltd., the principles involved in such special tools are so well brought out as to demand comment.

In order that such a lathe may do its best work it should have its highest powering at its high speeds, and this means that the initial belt speed should be high.

"The first impulse of those lathe designers who have paid particular attention to the production of a lathe for high-speed steel has been to follow the design of the ordinary lathe, but gearing it more powerfully than usual. This has given good results, but cone pulleys for such work have several disadvantages, the principal one being the very high speeds at which they must run to enable the requisite power to be obtained, rendering great care necessary to prevent heat-

ing of the bearings. It has also the disadvantage that the belt will only give a low power when on the largest step of the cone —owing to this being the slowest belt speed —at the very time when most power is required. For example, a cone pulley with a 12-inch small speed and a 24-inch large speed—the countershaft running, say, at 240 revolutions—will, allowing the belt to pull 600 pounds, give about 27 brake horse-power on the smallest speed, whilst on the largest speed—which, if anything, should have rather more power—it will only give about 13½ brake horse-power."

As a mater of fact the actual amount of power used by existing lathes is frequently over estimated, mainly because of the large proportion of power consumed in the transmission, and erroneously assumed to be taken by the machines. When, therefore, the amount of power demanded for the high-speed steel work is mentioned it does not seem more than the ordinary machine is supposed to take. As soon, however, as the attempt is made to increase the resistance at the point of the tool to 3 to 10 times that formerly used, the deficiency in powering becomes apparent.

In view of the fact that the actual work performed with the new steels, when operated under the most efficient conditions, is about three times that attainable with the ordinary steels, it may well be assumed that the powering should be increased in about the same proportion, and this fact should not be lost sight of in providing for the belt speeds and widths.

There is little doubt that the ultimate effect of the general introduction of high-speed steels will work important modifications, not only in the design and powering of the tools themselves, but also in the original installation of the machinery of motive power plants.

PRACTICAL EXPERIENCE WITH SUPERHEATED STEAM.

DETAILS OF SUPERHEATER CONSTRUCTION AND EXPERIENCE WITH HIGHLY HEATED STEAM IN ENGINES.

Prof. W. H. Watkinson—Institution of Naval Architects.

IN the consideration of possible lines of improvement for the steam engine, the one point upon which engineers are generally united is the fact that the principal source of loss lies in the condensation of steam in the cylinder. In all engines of the cylinder type this loss from condensation goes on and various methods have been devised to reduce its injurious action, or if possible, to prevent it altogether. Thus corresponding and multiple-expansion have been introduced for the purpose of separating the various stages of the operation of expansion. Again, all the various arrangements of steam jackets, reheaters and similar devices have been made, in the hope of diminishing the internal wastes, but the gain from these methods has been questioned, especially when the cost of installation and operation of the apparatus has been taken into account.

The most effective method of reducing cylinder losses by condensation is that of superheating the steam before it is delivered to the engine, and in a paper recently presented to the Institution of Naval Architects by Professor W. H. Watkinson, some interesting experiences with superheated steam are given.

We have referred to the losses from condensation as taking place in cylinder engines.

"The steam turbine is the only engine in which this condensation of the steam by previously cooled internal surfaces does not take place; but the steam in turbines is, of course, wet from another cause, namely, on account of the expansion it has undergone while doing work, and the efficiency of this type of motor is also very considerably increased when the steam is superheated prior to its admission to the engine. In steam turbines the reduction in the amount of steam required when superheated steam is used is due mainly to the increased volume and the decreased frictional resistance between the rotating vanes and the steam. In steam turbines of the De Laval type, using saturated steam, the discharge from the nozzle is generally more or less intermittent, due to the intermittent choking of the nozzle with the water in the steam. When the steam is superheated the discharge from

the nozzle is free and continuous, and the velocity, and therefore the efficiency of the steam, is on this account still further increased."

The various methods for reducing internal condensation other than superheating must be regarded as only palliatives, and superheating itself is the only means whereby condensation can be wholly prevented.

"An advantage incidentally obtained in most cases where superheating is adopted, follows from the reduced demand for steam on the boilers. Fewer boilers may in many cases be used, and those used may work at an easier rate; the result generally being that the efficiency of the boilers is also increased. In condensing engines, a still further advantage is derived from the fact that the use of superheated steam reduces the work to be done by the air pumps, feed pumps,and circulating pumps. In nearly all steam engines, far more steam leaks past the valves and pistons than is generally recognized. Professor Perry says: "'It is to be remembered that it is the existence of water round the piston and valves that enables leakage to be fifty times as great as if there was no water.'' By using superheated steam most of this leakage is entirely prevented, as is also the leakage at steam pipe and other joints. During superheating, although the pressure of the steam remains constant, its volume is greatly increased. The amount of heat required to superheat 1 pound of steam by 150 degrees, F., is 72 British heat units, which is only about 6 per cent. of the heat required to generate 1 pound of dry saturated steam. The increase in volume due to this additional 6 per cent. of heat averages about 30 per cent. In the case of large engines of the usual types it is not advisable to superheat the steam by more than about 200 degrees F., and is some cases there is much trouble with the valves if the degree of superheat exceeds 150 degrees F. When piston valves are used this limit can be considerably exceeded without difficulty, with a corresponding gain in efficiency. In the case of large triple expansion engines the consumption of steam could be reduced to below 8 pounds per hour per indicated horse-power by superheating the steam initially and between each stage of expansion."

In many instances the superheater is placed in the flue between the boiler and the chimney. This plan may well be adopted when the plant is a small one, and but two or three boilers are used. For larger installations Professor Watkinson prefers to use an independently fired superheater. One reason for this is that if a superheater is applied to each of a battery of boilers it is not known what each one is doing. One of the superheaters may be supplying steam nearly a temperature of red heat, whereas another, the boiler of which is being lightly fired, may be acting as a condenser. The cost of an independently arranged superheater is less than that of an apparatus attached to the boilers, and the convenience of manipulation is far greater. When the superheater is operated in connection with a gas producer a high efficiency is secured.

Professor Watkinson gives a detailed description of a form of superheater arranged for operation with gas firing, together with results of its operation. The superheater is of the small bent-tube type, the surfaces being exposed to the gases in such a manner that although they are white hot as they approach the first wall of tubes, they pass away from the superheater at a temperature of about 460 degs. F. Experience has shown that the best results cannot be obtained unless the hot gases reach the superheater at a temperature of at least 1,000 degrees F. This cannot well be accomplished with the waste gases from steam boilers unless the gases leave the boiler surfaces at a higher temperature than is consistent with the best economy. The temperature necessary for efficient chimney draught is between 500 degrees and 600 degrees F., and good boiler design should not permit the gases to escape at a temperature high enough to be most effective for purposes of superheating.

When superheaters are placed in the flues of steam boilers care must be taken to provide for the protection of the tubes during steam raising, as the absence of any flow of steam through the tubes permits the heat to accumulate. In some systems an arrangement is provided whereby the tubes may be flooded with water during the period of firing. Professor Watkinson has devised a shunt method for diverting the products of combustion from the superheater until the flow of steam is established. Other systems involve the use of cooling water-coils or similar devices but all these, which are

really necessary for superheaters set in boiler flues, are entirely unnecessary with the independently-fired apparatus.

The economy due to superheating has been effectively demonstrated in various tests and researches. In a case cited by Professor Watkinson, at a colliery in Lanarkshire, six boilers were required before the installation of the superheater, whereas afterwards but four were needed. In such a case the economy is not only that represented by the diminished coal consumption since the saving in labor, repairs, interest and depreciation upon the two boilers must also be considered.

The injurious action of highly heated steam upon the lubricants and upon the rubbing surfaces has been a matter for serious consideration. With the modern high-temperature cylinder oils, however, this injurious action has been reduced to a minimum, and when the lubricant is not used to excess, no harm need be anticipated. In many cases oil may be almost entirely dispensed with to marked advantage.

"In starting a new engine, or one with new piston rings, it is not advisable to attempt to use highly superheated steam until the valves, cylinder, and piston rings have acquired a glassy surface. If the superheat for the first few days be kept at, say, 40 degrees F., there should be no trouble, and after this time the superheat may be gradually increased until the maximum superheat suitable for the engine is attained. The above precautions are especially important in the case of engines having a high rotative speed. When the valves, cylinder, and piston rings have acquired a glassy surface, internal lubrication does not appear to be absolutely necessary." Professor Watkinson states that he has had an engine under observation for a considerable period, which is running most satisfactorily without internal lubrication, although the temperature of the steam is 500 degrees F.

WATER POWER IN BAVARIA.

A STUDY OF THE AVAILABLE HYDRAULIC POWER EXISTING IN THE NORTHERN WATERSHED OF THE BAVARIAN ALPS.

O. von Miller—Verein Deutscher Ingenieure

WITH the realization that commercial and industrial surpremacy, or even existence, depends upon the command of ample sources of motive power the study of available sources of water power has attracted attention of late, not only in countries lacking in coal, but also in those in which fuel is not wanting. Thus the possible water powers of Italy have been officially investigated, with the result that that land, without coal, has already developed some of the most important hydraulic stations of Europe; as various articles in the pages of this magazine have shown. In France, the possible power to be derived from the Alps has formed the subject of several important studies by engineers of the *Ponts et Chaussées,* and the interest which has been awakened in the utilization of the "white coal" has already produced substantial results, notably in the district about Grenoble.

The abundant water power sources existing in the Bavarian Alps form the subject of a paper by Herr Oskar von Miller, appearing in the *Zeitschrift des Vereines Deutscher Ingenieure,* and the systematic manner in which the subject is presented, as well as its importance to the industrial status of the kingdom of Bavaria, renders it desirable for abstract and review.

The whole northern slope of the Alps forms a gigantic watershed, delivering the flow of melting snows through innumerable streams into two great rivers, the Rhine and the Danube, and these latter may be regarded as tail-races, so to speak, of the mill powers possible upon their slopes. Her von Miller divides the watershed into three great districts, the Swiss, fed by the Ill, the Thur, and the Aare, with its tributaries, the Saane, Emme, Reuss, Limmat, etc., and discharging into the Rhine; and the Austrian, and the Bavarian districts, drained by the Danube, and including as power streams the upper Danube itself, as well as the Iller, Lech, Isar, Inn, Salzach, and others. Leaving the Swiss streams out of consideration, and discussing mainly the streams available in Bavaria, Herr von Miller proceeds to estimate

the theoretical and practical power at the disposal of the engineer. The importance of this district will be seen from the fact that already about 350,000 horse power is developed on the Bavarian and Austrian slopes, and the area has scarcely begun to be worked.

In making a detailed estimate of the total available hydraulic power of the Bavarian Alps, the method used is that of taking the fall of the various streams, as computed from the topographical maps, dividing off each stream into sections between which power stations may be placed, and computing the power for each stretch. In the upper regions the falls are naturally greater and the stations closer together, but the volume of water less than in the lower sections, and hence the distribution of power, to a certain extent, equalizes itself.

The total theoretical power in any section is readily computed from the head and volume of flow, and while in no case an absolute proportion of this theoretical amount can be utilized, yet it may be made a basis for estimating the actual power realizable. Instead of taking the available power as a constant percentage of the total, however, Herr von Miller has adopted the far more scientific method of assuming a high percentage of efficiency for the short, high falls, and a lower efficiency for the lower reaches of the respective streams. In this way he has tabulated the computations of total and effective power of the various streams in a manner which, when taken into consideration with the map, enables a very clear idea of the amount and distribution of power to be obtained. The grand total of the theoretical power available in the Bavarian Alps is computed to be 1,900,000 horse power, while, according to the conservative estimates of Herr von Miller, about 700,000 horse power of this is practically available, or seven times as much as is drawn from the falls of Niagara by the shaft and tunnel of the Cataract Company.

Naturally, the development of this power involves the installation of electrical and transmission plant; and indeed, as Herr von Miller indicates, an important demand for electrical current is for the development of electro-chemical industries. Thus the applications of hydraulically developed electrical energy for the production of aluminum, calcium carbide, and similar industries, are well known, while the possible uses in connection with the manufacture of glass, cyanides, alkalies, etc., must be considered, as well as the smelting of iron and the fining of steel.

The important element in comparing the relative value of hydraulic power with steam is the cost, and this point is examined by Herr von Miller with especial reference to the conditions existing in the Bavarian watershed. As in the case of the relative efficiency, the value of the higher falls is greater than that of the lower reaches of the streams, since, in the former instances the first cost of installation is less per horse power than in the latter.

Thus in the case of a fall of 1.5 meter, developing 240 effective horse power, the cost of installation was 1,000 marks per horse power. For a fall of 3 meters and the development of the same amount of power, the cost fell to 650 marks per horse power; while for a plant operating under a head of 80 meters and generating 6,000 horse power, the installation cost was only 200 marks per horse power. These facts should lead to the development of the high falls in the upper district, since not only is the original cost of plant kept at a minimum, but a higher operative efficiency is also attained. In this connection, however, the attendant costs due to the relative inaccessibility should be considered, as they may have an important bearing upon the commercial value of the site thereafter, since the value of the undertaking must depend largely upon the transportation facilities.

The discussion which has been given in this paper to the water power available in Bavaria should form an excellent model for investigations and reports elsewhere. There is little doubt that in the near future the power resources of a country will be deemed as fitting a subject for survey and public report as its mineral deposits, its agricultural areas or any other of its industrial potentialities.

Even if the utilization of the power be not in the hands of the State the general investigation of the subject may well be made on official matter, both because of the legal questions involved and because in no other way can the necessary publicity as to facts be secured.

THE DIESEL MOTOR IN ENGLAND.

COMPARATIVE DATA AND RESULTS OF PRACTICAL TESTS OF DIESEL OIL ENGINES IN ACTUAL SERVICE IN ENGLAND.

H. Ade Clark—Institution of Mechanical Engineers.

AT various intervals since the presentation of the rational heat motor of Herr Rudolph Diesel at the Cassel meeting of the Verein Deutscher Ingenieure we have referred to its progress in these columns. Naturally the development of the motor has been most marked in Germany, where it has had the advantage of the experienced attention of the inventor and his associates, while considerations of practical economy have led to its adoption in Austria and in Southern Russia, where the abundant supply of liquid fuel has rendered it especially applicable. In Great Britain, however, apart from some experimental work early in the history of the invention, but little has been done until recently.

About a year ago a Diesel motor of 35-horse-power, built in Germany, was installed by the Harrogate Corporation, and in order to confirm and verify the remarkable results which had been obtained on the Continent and in America, Mr. H. Ade Clark, of the Yorkshire College, Leeds, took the opportunity of testing this motor. The results of these and some other tests are embodied in a paper presented by Mr. Clark at the recent meeting of the Institution of Mechanical Engineers, forming a valuable and interesting addition to our stock of information concerning internal-combustion motors.

Mr. Clark begins his paper with a general description of the construction and operation of the motor, to which but brief reference can be made here, as it has already been more fully set forth in these pages. Briefly the motor is an internal-combustion engine of the four-cycle or Beau-de-Rochas type in which an attempt is made to approximate, as closely as practical conditions will permit, to the ideal cycle of Carnot. Taking the four portions of the cycle in succession, the first out-stroke admits air to the cylinder, the next in-stroke compresses it adiabatically to a pressure of about 500 pounds per square inch, producing a temperature of about 1000 degrees F.; the liquid fuel is then injected and ignited by the high temperature of the air, and burns, producing isothermal combustion, followed by adiabatic expansion, this being the power stroke; finally, the return is the exhaust stroke, the contents of the cylinder being discharged, and the cycle completed. The high ignition temperature, the excess of oxygen present, and the freedom for combustion due to the pressure, all unite to produce a remarkably complete combustion even of thick and inferior oils, petroleum residues burning as freely and completely in the cylinder as benzine or gasoline. The close approximation to the cycle of maximum efficiency renders the motor capable of returning a much greater proportion of the fuel in useful work than has hitherto been possible, tests made in Germany, Belgium, France, and the United States agreeing in showing thermal efficiencies of 37 to 39 per cent., or more than double that attainable in the best large steam engines, and 50 per cent. higher than that of other internal-combustion motors.

The tests of Mr. Ade Clark being the first trials of the first Diesel motor put to work in England, naturally attracted much attention, and the fullness with which the data and results are tabulated in the paper leaves little to be desired. Briefly, the results fully confirm the experience obtained in other countries. The quantity of oil consumed by the engine when developing 40-horse power was 0.46 pounds per *brake* horse power, giving a thermal efficiency of 36.3 per cent. Mr. Ade Clark also gives results of a test made by him on an 80-horse power Diesel motor at the works of Messrs. Carels Frères, Ghent, Belgium, showing consumption of 0.43 pounds of oil per brake horse-power-hour and a thermal efficiency of 39.9 per cent.

These results fully confirm the records of high efficiency shown by the Diesel motor elsewhere, and should go far to demonstrate to engineers and power users in Great Britain the accuracy and value of the Continental trials. Apart from the manner in which

the results check each other, it is interesting to note the improvement in the mechanical efficiency of the motor. The earlier machines showed that only about 75 per cent. of the indicated power was delivered as effective power at the brake, the remaining 25 per cent. being expended in overcoming the friction and other internal resistances; these latter owing to the high working pressures being greater than in other engines.

The mechanical efficiency of the later motors has progressed from 80 to 85 per cent., thus enabling a far greater proportion of the high thermal efficiency to be utilized, so that in this respect the motor does not fall behind other machines of its class.

An interesting portion of Mr. Ade Clark's paper is that in which he compares the actual cost of power generated by the Diesel motor, the gas engine, and the steam engine respectively. The details of these costs are gone into very fully, being tabulated and classified so as to show the proportion of capital depreciation, maintenance, and operative charges in each case. The motors compared with the Diesel are: the Crossley-Otto gas engine, supplied from a Dowson producer, and a standard high-speed compound condensing steam engine. The fuels taken are: for the Diesel, crude petroleum at 45s. 0d. per ton; for the gas producer, anthracite cobbles at 24s. 0d. per ton; and for the steam engine, coal at 12s. 6d. per ton. Including capital, depreciation, and operative costs the total cost per brake horse power works out according to Mr. Clark, as follows: Diesel motor, 0.59 penny; gas engine, 0.69 penny, and steam engine, 0.89 penny. These results will doubtless be subject to correction for various locations, according to the local price for fuel, the Diesel making a much better showing in the oil regions, while the steam engine will show a lower cost of power when situated near the pit-mouth, but as given they may be accepted as fairly average conditions in Great Britain.

While the Diesel motor, as at present designed is intended for use with oil fuel the principles involved are equally correct for gas or for powdered solid fuels, and there is every reason to believe that the principle of the combustion of the fuel in the working cylinder in accordance with a correct thermo-dynamic cycle is the true method of attaining the maximum efficiency.

So far as the oil engine is concerned the results of practical experience in Germany have shown its complete adaptability to stationary, marine, locomotive and automobile purposes, and the trials in England as reported in Mr. Ade Clark's paper fully confirm all that has been done elsewhere.

HIGH-SPEED TOOL STEELS IN ENGLAND.

DISCUSSION OF THE MERITS OF RAPID-CUTTING TOOL STEELS AND THEIR INFLUENCE ON MACHINE-TOOL DESIGN.

Institution of Mechanical Engineers.

AT the Leeds meeting of the Institution Mechanical Engineers an animated discussion was elicited by a brief paper presented by Mr. H. H. Suplee, containing some notes upon the performance of high-speed tool steels at the Omaha shops of the Union Pacific Railway. The paper itself contained some verified data concerning the speeds and performances attained in the course of ordinary shop practice, showing, as has been the case elsewhere, that for heavy roughing work from three to ten times the quantity of metal could be removed by use of the new steels as had been possible with the ordinary tools.

The discussion was interesting in that it showed that up to the present time the modern tool steels were but little used in England, with the exception of some progressive establishments which were conducting experiments on their own account but were not yet prepared to make the entire results public, while in some few instances there appeared an unwillingness to accept the material as a very great advance over older tools. At the same time a number of eminent engineers showed themselves fully alive to the great importance and value of the subject, so that the discussion should prove of value as awakening public interest in the matter.

Speaking for the older methods of doing work, Mr. Joseph Barrow drew from his ripe experience some valuable features con-

cerning the relation of the form and position of the tool in connection with maximum output, and was rather inclined to feel that when all these facts were fully considered the difference in performance between the older steels and the new material was not so great as might at first appear, but it was readily made apparent that the same care devoted to the form of the tool with the rapid steels would enable them to benefit by this experience also.

Numerous speakers, however, corroborated the greatly increased cutting capacity of the new steels, and the practical trend of the discussion bore upon the effect of the improvements upon the design of machine tools. The true position in this respect was well brought out by Mr. Hartnell, who said that his own experience showed that existing machine tools would soon break down under the severe work thrown upon them, but that he was convinced that the machines would have to go and be replaced by stronger and more heavily-powered tools. The question of increased power expended also came up for consideration, but Mr. Wicksteed called attention to the fact that the increased consumption of power was accompanied with a corresponding increase in output, and, in fact, the proportion of effective to total power is greater than when the machines are using less.

An interesting feature in connection with the introduction of rapid-cutting steels is the association of their introduction in connection with improved wage systems. When premium or bonus wage systems are introduced, by means of which the wage of the workman depends in some direct proportion to his output, his interest is awakened in all that relates to greater rapidity of production, and it is found in actual experience that improved wage systems and improved tool steels frequently go hand in hand. There is no better comment upon the value of the premium system than the fact that it aids in the development of improved methods and appliances for doing work, methods which make little or no greater demands upon the physical effort of the workman, but do develop the application of his mentality and observation.

In connection with the modifications in machine-tool design due to the imposition of heavier burdens, attention was called to the unsatisfactory plan of putting a more powerful head upon a lathe bed of older proportions, the result being what Mr. Barrow called a "hydrocephalous" lathe, a type certainly not to be desired or imitated. With any increase in powering there should certainly be given a great increase in strength and stiffness, as otherwise the machine is certain to spring under the increased stresses which will be put upon it. The modern machine tool must certainly be designed upon what has aptly been called the "anvil" principle, as opposed to the "fiddle" principle with which it has been contrasted, while the "big-headed" type should be discouraged.

THE PURIFICATION OF DRINKING WATER.

A COMPARISON OF THE PROTECTION OF GATHERING GROUNDS WITH THE EFFECTIVENESS OF FILTRATION METHODS.

S. Delépine—British Association of Waterworks Engineers.

ALTHOUGH there is a general union of opinion as to the importance and necessity for the provision of a pure water supply to cities and other communities, there is by no means a general unaminity of opinion as to the best method by which this most desirable result is to be attained. For this reason the paper of Mr. S. Delépine, the Directr of the Manchester Laboratory of Public Health, presented at the recent meeting of the British Association of Waterworks Engineers, is of present importance and interest.

Starting with the assumption that we have an original source of pure water in the rain which falls to the ground, Mr. Delépine proceeds to show how it becomes polluted.

In the first place, the air itself, above densely populated districts, is charged with bacteria. Examinations of air in various localities and at different altitudes show that in 10,000,000 cubic centimeters of air the number of bacteria ranged from 0 at heights of 2,000 to 4,000 méters in the Bernese Alps, to 55,000 in the Rue de Rivoli,

Paris. Thus, even before it reaches the ground, rain water falling over densely inhabited parts becomes loaded with bacteria, chemical products, and various living organisms. Rain and snow falling through the atmosphere of large industrial towns may thus be loaded with impurities to an extent which is hardly conceivable.

Upon reaching the ground the rain water comes in contact with a very large number of bacteria. Professor Delépine gives results of a number of examinations of soils, showing the aerobic bacteria in one gramme of soil to vary from 1,600 in dry sand to 78,000,000 in street mud of large cities, so that the possibilities of contamination are very great.

"The extent to which surface waters become loaded with soil bacteria depends upon various conditions. Water falling upon uninhabited, bare, impervious, rocky grounds, forms at once streams which remain pure until they reach cultivated regions. Rain falling upon grassy slopes, and especially upon boggy, peaty land, is generally retained for some time, unless the slopes are very steep or the ground already saturated with water. In the latter case the water carries with it to the surface streams all the surface impurities, including surface pollutions, with which it comes in contact; but when the water is retained by grass or a superficial stratum of porous soil, it gravitates more slowly towards the rivulets, and carries with it but few of the soil bacteria. This percolation continues to take place slowly after the cessation of rain, so that the water collected from small streams during dry weather is purer than that collected during rainy weather."

When the water penetrates deeply, owing to the superficial layer of porous soil being thick, an almost complete bacterial purification takes place. It is this natural method of purification which is sought to be reproduced in the construction of slow sand filters. Careful examinations of subsoil waters in which the surface of the ground is rich in bacteria, show that at depths of 2 to 5 metres there is almost a complete absence of bacteria. The real cause for the pollution of water, then, is to be found in the surface washings which find their way into streams without being filtered through suitable soil.

Thus, the manuring of land, or the presence of even a small number of human habitations in the neighborhood of feeders or reservoirs of moderate size, is attended with a marked increase of organisms, among which are frequently found fæcal bacteria growing well at the temperature of the human body.

"An increase in the number of bacteria is not in itself a sign of actual danger, but indicates, especially when there is clear evidence of the presence of bacteria usually found in the human intestine, that there is a potential danger, for where bacteria coming from healthy beings, human or animal, can find their way, those issuing from diseased individuals may also penetrate at times."

In the case of reservoirs of moderate size, in which the gathering ground may be thoroughly and carefully inspected, the sources of pollution may usually be detected. Whenever possible, this system should be adopted, and Professor Delépine is fully convinced that protection is better than filtration when it can be fully and properly carried out. Supplies from river water, however, involve purification by filtration, since it is impossible to secure a proper inspection and protective supervision of the gathering grounds. The conditions involved in successful filtration have been well laid down by Koch. These include means for meeting widely varying demands, without overworking the filters at any time; means for preventing freezing; means for regulating the flow of filtered water, and consequently the rate of filtration; and means for testing bacteriologically the water immediately after it has passed out of each filter bed. Water which is found to be insufficiently purified should be diverted from the distributing system, even though much water is lost thereby, and the most careful and constant supervision by a thoroughly competent engineer is an essential to security.

Comparing the precautions which are necessary to insure the safe operation of sand filters, with the extent and nature of the care required to protect the gathering grounds, Professor Delépine shows that in many instances the latter is the better and less costly method.

In many instances, however, polluted

water must be used for drinking purposes, and in such cases filtration is invaluable, although it cannot be considered as entirely satisfactory. Where entire sterilization is required it appears probable that the use of ozone may be found the best process available, and the experiments of a number of investigators in Germany, Holland and France, go to show the entire practicability of the progress, questions of cost alone remaining to be solved. It is not improbable that filtration followed by treatment with ozone may ultimately be adopted as combining the essentials of complete sterilization with practicable limits of cost.

In summing up the discussion of the purification of drinking water Professor Delépine concludes that:

Filtration of unpolluted water is unnecessary as a protection against disease.

Filtration of polluted water, even when well conducted, is not always an absolute safeguard against disease.

To make filtration efficient within the limits of the possible, constant skilled supervision and provision against possible breakdowns are needed. Efficient filtration involves a considerable initial and permanent expenditure.

The initial expenditure caused by the acquisition and depopulation of gathering grounds varies, and in some districts may be considerable, but this is not usually the case.

The supervision of depopulated gathering grounds requires no special skill, and may be carried out efficiently with a small permanent expenditure.

When expense is not a matter for consideration the best results are obtained by a combination of protection with well-conducted filtration; but whenever expenditure makes it a matter of necessity to choose between filtration and protection, Professor Delépine maintains that protection is better than filtration, which is really equivalent to saying that prevention is better than cure.

STREET AND ELECTRIC RAILWAYS IN AMERICA.

A UNITED STATES CENSUS REPORT SHOWING THE RAPID GROWTH OF THE STREET AND ELECTRIC RAILWAY INDUSTRY.

United States Census Bulletin.

ELSEWHERE in this issue are given some figures showing the present status of street and electric railways in Germany. A recent United States Census Bulletin contains similar statistics for America, some of which are here presented by way of comparison, as well as for their own great instrinsic value.

The bulletin was prepared by Messrs. T. Commerford Martin and E. Dana Durand, special experts, and is issued by Mr. W. M. Steuart, the chief statistician for manufactures. The statistics contained therein cover all street and electric railways in the United States that were in operation during any part of the year ending June 30, 1902. During this period "there were in existence 817 operating electric railway companies and 170 leased companies, making a total of 987 companies. These companies owned or controlled 22,576.99 miles of single track. The par value of the capital stock and funded debt outstanding, as reported, amounted to $2,308,282,099. The average net capital liabilities per mile of single track owned for the companies reporting both factors were $96,287. The total income and expenses of the operating companies amounted to $250,504,627 and $219,907,650, respectively. The companies gave employment on the average during the year to 133,641 wage earners, and paid $80,770,449 in wages. There were 7,128 salaried officials and clerks employed, to whom $7,439,716 was paid in salaries. The roads carried 5,871,957,830 passengers of all kinds."

A number of the street railway companies in existence at the census of 1890 failed to make reports to the Census Office, and, therefore, a comparison of the statistics of the two censuses is, to that extent, defective, exaggerating somewhat the growth which actually took place. From the items as reported, it appears that the single track mileage increased from 8,123 miles in 1890 to 22,577 miles in 1902, or 178 per cent., and the number of fare passengers carried from 2,023,000,000 to 4,810,000,000, or 138 per cent.

"The term 'street and electric railways,' as used in the bulletin, includes all electric railways irrespective of their length or location, and all street railways irrespective of their motive power. At the census of 1890 the railroads that used motive power other than steam were confined almost exclusively to urban districts and were properly classed as street railways, but the application of electricity has enabled these roads to greatly extend their lines in rural districts, and a large proportion of the trackage is now outside the limits of cities, towns or villages. That the use of electric power has been the principal factor in the development of these railways during the past twelve years is shown by the following table, which presents for the years 1890 and 1902, the number of companies and miles of single track in the United States, segregated according to motive power:"

	1902		1890	
Power.	Companies.	Single Track.	Companies.	Single Track.
Electric	747	21,920	126	1,262
Animal	67	259	506	5,662
Cable	26	241	55	488
Steam	9	169	74	711
Total	849	22,589	761	8,123

In this table fractional parts of miles are omitted. The total for 1902 includes 12 miles of track duplicated in reports of different companies, and in the figures for electric roads of that year are included 6 miles operated by compressed air. Of the electric roads, 21,280 miles were single overhead trolley, 23 miles double overhead trolley, 266 miles conduit trolley, 343 miles third rail, and 2½ miles storage battery.

"The length of single track, 22,589 miles, reported for 1902, consists of 16,652 miles of first main track, 5,030 miles of second main track, and 907 miles of sidings and turnouts. Of the total single-track mileage, 21,914 miles, or 97 per cent., were operated by electric power, and 416 miles, or 1.9 per cent., by other mechanical traction, while only 259 miles, or 1.1 per cent. were operated by animal power, as compared with 69.7 per cent. operated in the last way in 1890. Of the total trackage in use by all companies, 84.3 per cent. was owned by the operating companies, and 15.7 per cent. leased. The mileage of track constructed and opened for operation during the year covered by the report, was 1,550 miles, or 6.9 per cent. of the total, but this does not cover all of the track under construction, which it was impracticable to enumerate. For the United States, exclusive of Massachusetts, where this classification was not made, 13,208 miles of single trackage, or 65.8 per cent. of the total, were reported as within urban limits, and 6,856 miles, or 34.2 per cent., as outside of such limits.

"The increase in the trackage is due not only to the establishment of new companies, but very largely to the extension of the lines of established companies. The 'length of line,' as mentioned in the report, means the length of the roadbed, or in the case of a railway lying entirely within city limits, the length of street occupied. In determining the length of single track, switches and sidings are included, and double track is reckoned as two tracks. The increase in the length of line during the period of twelve years amounted to 11,532 miles, or 225 per cent., as compared with an increase of 14,466 miles, or 178 per cent., in the length of single track. Single track roads are characteristic of rural districts, and the fact that the percentage of increase in length of line is greater than in length of single track is due principally to the great development of interurban single track since 1890.

"The average length of line per operating company in 1890 was 7.41 miles as compared with 20.38 miles in 1902, so that in the latter year the average company controlled almost three times the length of line that was operated by the average company in 1890. In 1890 there were only 8 companies operating more than 50 miles of line, and in 1902 the number of such companies had increased to 69. Of this number, 25 companies operated over 100 miles each, with a total length of line of 4,349 miles. Of the total number of companies reported for 1890, 94.9 per cent. operated less than 20 miles of line each, and their combined length of line amounted to 71.5 per cent. of the total in the United States; in 1902 corresponding percentages were 75 and 30.7, respectively. Thus, while there are still a large number of companies that operate less than 20 miles of track the percentage of the total length of line operated by them is not half what it was in 1890.

There were 66,784 cars of all classes re-

ported. The largest number, 3,612, reported for a single company is given for the Boston Elevated Railway Company, of Boston, Mass., which includes cars operated on both surface and elevated tracks. There were 60,290 passenger cars, and 6,494 cars used for express work or other purposes. Of the passenger cars, 32,658 were closed and 24,259 were open. Combination closed and open cars were reported by 105 companies, the total number being 3,134, of which 38.4 per cent. were used by 22 companies in California. There were 239 combination passenger and express cars; 1,114 express, freight or mail cars; 2,860 work and miscellaneous cars; 1,727 snowplow cars and 793 sweeper cars. There were 50,699 cars provided with electric equipment, and as the roads operated entirely or in part by electric power reported a total of 64,618 cars of all classes, the number of trailers on electric roads was about 14,000, and the number having electric equipment was 78.5 per cent. of the total. Of the passenger cars, each traveled, on the average, 18,003 miles and carried 97,395 passengers during the year.

"Steam was used by 540 companies as the primary motive power to generate electric current. The statistics concerning steam power classify the engines according to horse-power. There were, in all, 2,336 engines, with a total horse-power of 1,298,133, or 556 h.p. per engine. Of this number 1,588 engines each were reported as having 500 h.p. or under, with a total horse-power of 420,551, or an average of 265 for each engine. There were 431 engines having a horse-power of over 500 but under 1,000 each, the total horse-power being 297,757, or 691 per engine, and 317 engines having a total horse-power of more than 1,000 each, the total being 579,825 h.p. or 1829 per engine. The Pittsburg Railway Company, of Pittsburg, Pa., reports forty-seven engines, which is the largest number returned by a single company. The greatest amount of steam horse-power, 79,075, is reported by the Interburban Street Railway Company, of New York, N. Y. The greatest number of large engines, i. e., engines having more than 1,000 h.p. each, is reported by the Union Traction Company, of Philadelphia, Pa., which had twenty-one engines with a total of 37,800 h.p., but the Interurban Street Railway Company, of New York, N. Y., with only fifteen engines, reported a horse-power capacity of 78,600, while the Boston Elevated Railway Company, of Boston, Mass., with twenty engines, reported a total of 48,200 h.p.

"There were 159 water-wheels, with horse-power of 49,153, used as the primary power in the generation of electric current. The average horse-power per water-wheel was 309. There were 129 wheels of 500 h.p. or less, twelve of over 500 and under 1,000, and eighteen of 1,000 and under 2,000. Of the total horse-power 34,215, or 69.61 per cent., was reported by sixteen companies in the States of California, Georgia, Maine, Minnesota and New York. The largest plant of this character was shown for the Twin City Rapid Transit Company, of Minneapolis, Minn. This company reported the use of twelve water-wheels, ten of which had 1,000 h.p. each."

The direct-current electric generators numbered 2,861, with a total horse-power of 972,314, the number having a capacity of 1,000 horse-power and over being 209, with an output of 330,456 horse-power. There were 441 alternators, with 231,924 horse-power, those over 1,000 horse-power numbering 58, with a capacity of 133,571 horse-power. In the main stations, storage batteries having an aggregate horse-power of 19,744 were reported, while the storage batteries in sub-stations had a total of 39,249 horse-power.

"Of the 5,871,957,830 passengers carried, 4,809,554,438, or 81.91 per cent., were fare passengers, and 1,062,403,392, or 18.09 per cent., were transfer passengers. The transfer passengers included those using free transfers, also in a few cases those using transfers for which an additional payment was required. There were 4,455 transfer points reported. The average number of fare passengers per mile of single track operated in the United States was 208,600. In preparing this average only the companies from which complete statistics were received are considered. Of the total car mileage, 1,099,256,774, the passenger cars travelled 98.7 per cent., and the freight, mail, express and other cars, 1.3 per cent. The fare passengers per car mile for all companies averaged 4.43."

Some comparative financial summaries are given in the following table, but the

totals for 1890 do not include returns from all the companies. The figures are in millions of dollars:

Items.	1902.	1890.
Cost of construction and equipment	$2,168	$389
Capital stock issued	1,316	289
Funded debt outstanding	993	189
Earnings from operation	248	91
Operating expenses	142	62
Percentage operating expenses of earnings	57.5	68.4

It is impossible, in a brief review, to even mention all the interesting features of these statistics, the completeness of which may be gathered from the fact that all the street-railway companies in the United States, with the exception of 22, have furnished complete returns. It is hoped that even these last will supply satisfactory statements in time to be included in the final report now in preparation, which will contain many details not given in the preliminary report, together with a careful analysis, and an elaborate discussion of the development of the modern electric railway system.

STREET AND ELECTRIC RAILWAYS IN GERMANY.

STATISTICS OF THE STREET AND ELECTRIC RAILWAYS IN OPERATION AND UNDER CONSTRUCTION IN THE GERMAN EMPIRE.

Elektrotechnische Zeitschrift.

EVERY year the *Elektrotechnische Zeitschrift* publishes the statistics of electric railways in Germany, and a few extracts from the latest report may be of interest. Figures are given for all the electric railways in public service, including surface roads, elevated railways, and all other kinds, both urban and interurban.

The great majority of the roads have overhead trolley wires of the usual construction. Part of the Königsberg system has double overhead wires, forming outgoing and return circuits. The cities which have conduit roads are Berlin, Charlottenburg, Dresden, and Düsseldorf.

There are combined overhead and accumulator systems in Berlin and several other cities, and in two places, Bremerhaven and Ludwigshafen, the cars are operated by accumulators alone. In Bremerhaven there is a street line with seven motor cars, each of which carries 86 storage battery cells, with a capacity of 300 ampere hours. Connecting Ludwigshafen, Worms, Neustadt and other cities of the Palatinate, there is a standard-gauge railway about 100 miles long, including branches, which was formerly operated by steam, but on which now run large accumulator cars with such trailers as the traffic demands.

The Berlin elevated and underground railway and the newly opened suburban standard-gauge road between Berlin and Gross-Lichterfelde are operated with the third-rail conductor, while the high-speed experimental line from Marienfelde to Zossen is the sole representative of the triphase system. Between Barmen, Elberfeld and Vohwinkel there is the famous suspended railway, where the cars run on a single, overhead rail, and in Barmen there is also an electric rack-railway, running up the side of a hill and continuing on as an ordinary adhesion road into the surrounding country. The road between Frankfort-on-Main and Offenbach has a peculiar overhead conductor, consisting of a slotted tube, in which slides a contact piece.

Almost all the railways have a gauge of either 1 meter or 1.435 meters (4 feet 8½ inches); among the few exceptions are Düsseldorf, with 1.445 meters, and Brunswick, with 1.1 meters.

During the year 1902, electric railways were put in operation in the following cities: Colmar, Cologne, Freiberg in Saxony, Freiburg in Breisgau, Halle-Merseburg, Hamburg-Harburg, Heidelberg and Metz. Large additions to existing lines were made in Berlin, Breslau, Dresden, Hamburg and Upper Silesia. On October 1, 1902, there were electric railways in 125 different cities and districts, compared with 113 the year before. In the early part of 1903, 5 more systems were installed, making a total of about 130 at the present time.

The increase in the length of lines during 1902 was 300 kilometers (186 miles),

and the roads since completed and under construction amount to about 400 kilometers (249 miles) more, so that the total length of the electric roads is now about 3,800 kilometers (2,360 miles). The length of single track is about 5,700 kilometers (3,540 miles).

The capacity of the generators which furnish current for electric railways rose from 108,000 kilowatts on October 1, 1901, to 122,000 on October 1, 1902, and since then it has increased about 2,000 kilowatts, so that the total output of traction generators is now about 124,000 kilowatts. Some of these machines are in stations generating current for railway purposes only, while others are in combined light and power stations. Accumulators now play an important part in railway power stations, either as load equalizers, or as a reserve, and their total capacity is now over 30,000 kilowatts, as against 25,500 a year ago. The great and growing importance of electric traction as a means of transportation is shown still more strikingly by the figures for cars, the number of motor cars having increased during the past year from 7,300 to 12,500, and the trailers from 5,000 to 8,000.

In addition to the foregoing technical statistics, some figures concerning the operation and finances of the street railways, taken from the *Zeitschrift für Kleinbahnen*, may be mentioned. According to this journal, there were in Germany, at the end of 1901, 186 street railway lines, including electric and horse railways, with a length of 3,007 kilometers (1,868 miles). During the year 1901, 1,044 million passengers were carried, and the receipts amounted to 108 million marks. A summary of the street railway traffic of the ten largest cities is shown in the following table:

City.	Population.	Passengers, in millions.	Length in miles.
Berlin and suburbs	2,530,000	330	218
Hamburg-Altona and suburbs	870,000	108	92
Munich	500,000	53	30
Leipzig	460,000	65	63
Breslau	420,000	32	27
Dresden	390,000	74	75
Cologne	370,000	31	35
Frankfort-on-Main	290,000	52	31
Hanover, with Linden	290,000	26	105
Nuremberg	260,000	18	16

The average receipts per passenger varied from 8.8 pfennigs (2.1 cents), in Breslau, to 10.9 pfennigs (2.6 cents) in Hamburg. The net receipts of some of the municipal street railways were: Munich, 1,765,903 marks ($420,000); Frankfort, 1,729,440 marks; Düsseldorf, 307,774 marks; Mannheim, 259,543 marks; Cologne, 224,382 marks; Königsberg, 210,840 marks; Munich-Gladbach, 106,843 marks ($25,000). The dividends of the street railway companies varied from nothing to 19 per cent. Three companies divided more than 10 per cent. among their stockholders; 26 between 5 and 10 per cent.: and 21 between 3 and 5 per cent.

Although the past year in Germany was a very poor one for the electrical industry in general, there was decided activity in the electric railway field, and it is owing to this circumstance that the general economic depression did not have even more serious results for the electrical business. The street railways are operated almost entirely by electricity, and the electrification of the secondary railways is under way.

THE HUDSON RIVER TUNNEL.

THE PRESENT CONDITION OF WORK ON THE ELECTRIC RAILWAY TUNNEL UNDER THE HUDSON BETWEEN JERSEY CITY AND NEW YORK.

The Engineering Record.

ONE of the earliest transportation problems of New York was that of providing means of communication across the Hudson River with the New Jersey shore and thus with all the country lying to the west and south. Canoes, row boats, sailing craft and steam boats have all been used in turn, but even the most modern types of double-deck, screw ferry boats are not fully able to meet the demand for a

rapid and unfailing method of transportation which shall be independent of wind and weather, fog and ice. In consequence, therefore, of the inevitable drawbacks of even the best ferry service, many plans have been devised for bridging or tunneling the Hudson. One or more of the bridge schemes seemed in a fair way of accomplishment, when the farsightedness and courageous enterprise of the Pennsylvania Railroad in deciding to drive a tunnel under the river and into the heart of the city put a new aspect on the situation and revived interest in subterranean methods of solving the transfluvial problem.

Nearly thirty years ago a tunnel scheme was successfully promoted and the construction was begun in 1874, according to an article in a recent issue of *The Engineering Record*. The tunnel was to run from the foot of 15th street, Jersey City, to the foot of Morton street, New York, and was to have two tubes. Work was continued intermittently until 1882, when, after constructing about 2,000 feet of the north tube and 550 feet of the south tunnel, the original company suspended operations. An English company was organized to carry on the work, but they also abandoned it in 1891, although not before the north tube had been driven nearly 4,000 feet from the Jersey shore.

"When work was commenced, there were few precedents of such construction, on a large scale under similar conditions; and as the conditions were very difficult, the work was costly and dangerous, it having been reported that over four million dollars were expended upon it. It was originally known as the North River Tunnel, and the work was in charge of some of the first men in this country to use the pneumatic process. A shield was not at first employed and the attempt to excavate the very fine soft silt in a large heading eventually caused a disaster which cost many lives. The excavation was made under pneumatic pressure and the cast-iron lining segments were fitted into position as rapidly as practicable so as to leave the least possible amount of unsupported earth and silt. Great difficulty was found in keeping up the pressure, as the earth was not dense enough to retain the air thoroughly and its escape was immediately followed by an inflow of water. This was always preceded by a hissing sound which gave warning so that the men could usually stop the hole with clay before the water commenced to enter. On one occasion a leak suddenly developed which was so large that it was impossible to stop it with the clay and straw at hand because they were immediately forced through the opening by the air pressure. In this emergency Capt. John Anderson, the superintendent, with great heroism, placed his body in the opening and remained there until his assistants could insert clay between him and the earth and gradually close the dangerous leak. Later on a large leak occurred and before all the men could escape the door of the air-lock became jammed so that it could not be operated and the remainder of the men working there were drowned. These events happened many years ago under the earlier administration, but they are of interest as showing the perils which were met, and the great advance in methods and appliances which have since been made and now prevent the danger of future accidents of a similar nature."

At the time of its abandonment, in 1891, the north tube had been made secure and allowed to gradually fill with water. "In the latter part of 1896 and the early part of 1897, the bondholders took possession and gave instructions to have the tunnel freed of water for the purpose of examining its condition. On completion of this work, it was found that the work previously done, with the exception of some 470 feet, was in a satisfactory condition and re-organization then proceeded, the New York & New Jersey Railroad Company finally being incorporated with abundant capital to carry on and complete the work.

"During this time the tunnel was maintained, regularly pumped and kept in good condition until in April, 1902, orders were given to prepare to proceed with the construction work. The plant which had been installed on the New York side of the river had been entirely removed, the shaft allowed to fill up, the top was covered and it was completely abandoned. At the New Jersey shaft, the existing buildings were of light wooden construction and the machinery installed therein was for the most part out of date and in very bad condition. It was decided to make a complete sweep of all the

existing plant and to remodel the whole installation with an entirely new and modern equipment for safe and rapid construction and at the same time to build the plant fireproof so that there might be no danger to the works from fire at the surface buildings.

A steel frame building was erected at the New Jersey end of the tunnel, and divided internally for the various offices and dressing rooms, and to accommodate the machinery installed on the surface.

"The shaft at the west end of the north tunnel is 30 feet in diameter and 65 feet deep. It is lined with brick and is enclosed in the power house where the operating plant is installed. The north tunnel has a clear internal diameter of 18 feet 1¼ inches and an external diameter of 19 feet 5¼ inches. The south tunnel has corresponding diameters of 15 feet 3 inches and 16 feet 7 inches, and both are built with cast-iron linings or shells made with segmental plates flange-bolted together. The north tunnel shell is composed of rings 20¼ inches long, each of them having eleven segments and a key 11 inches long at the crown. The segments have a web 1½ inches thick and flanges on all sides 8 inches deep over all and about 2¼ inches thick at the base. They are slightly tapered and have parallel bearings for steel bolts 1¼ inches in diameter. The inner edges of the flanges have wedge-shaped clearances for packing and the flanges are stiffened by transverse ribs or webs about 10 inches apart and 1 inch thick. Through the center of each segment there is a grout hole 1¼ inches in diameter which is closed with a screwed plug. The weight of one ring, 20¼ inches long, is about 12,765 pounds, which is equivalent to 7,565 pounds per linear foot, the segments thus weighing a little more than 1,100 pounds each. The lining for the south tunnel is composed of similar rings 24 inches long, each made with nine segments and a key and weighing 11,340 pounds, equivalent to 5,670 pounds per linear foot.

"The principal difficulty in the construction lies in the very soft silt which has to be penetrated, the very thin roof which is left over the tunnel, and in the fact that the surface of the bed rock is so irregular that in some cases the tunnel is partly in rock and partly in silt. No large tunnel has previously been built with a shield working partly in silt and partly in rock, and the work which is now in progress by this method is consequently of special interest.

"The shield installed by the former management has been overhauled and altered in many respects, and in its present condition is being used for the north tunnel with entire satisfaction. This shield, however, was designed for use only in the Hudson River silt and was not originally adapted for use when rock occurred at the invert and silt over the arch. Construction was therefore suspended after it had been advanced a short distance and an excavation was made in the front of the shield in which an apron was built. This extended 6 feet in advance of the face of the cutting edge and reached from side to side of the shield itself. It was built of 12-inch I-beams and ¾-inch steel plates riveted solid with the shield itself and heavily stayed. Under it the sides and face of the excavation were heavily timbered and closely poled. The apron permits the advance of the chield in all cases where the rock does n extend 6 feet above the lower part of the cutting edge. The apron thus affords a 6-foot shelter for the men drilling and excavating the rock below it, and, in the chief engineer's opinion, has given absolute satisfaction in its operation.

"The shield measures 19½ feet inside of the tail piece and is advanced with sixteen 8-inch hydraulic jacks. The pressure developed in the jacks corresponds with the amount necessary to push the shield forward, and varies day by day according to the character of the soil. The cast-iron lining plates are assembled in the rear of the shield by a double-acting radial hydraulic erector with hydraulic swivelling gear. The erector is independent of the shield and is moved forward as needed.

"The north tunnel is equipped with a cable hauling system, built in three independent sections which are separated by the air-locks. The first section, 1,575 feet long, reaches from the foot of the shaft to the first air-lock; the second section, 1,660 feet long, reaches from the first to the second air-lock; and the third section extends with a variable length from the second air-lock to the working face. Each section is operated by a special hoisting engine.

"A temporary wooden floor is built

through the tunnel on its horizontal diameter, and on it are laid two 21-inch tracks, about 5 feet apart on centers, which reach from the shaft to the working face. All of the machinery and all the cable, except what lies between the tracks to receive the car grips, is underneath the temporary platform. When the heading has advanced from 10 to 20 feet beyond the end of the cable system, a tension carriage below is moved back a corresponding distance and the movable section of the track and front platform are moved forward on the working platform and secured there ready for continued service, the whole operation being easily and quickly made and not requiring special adjustment. After the heading has advanced 700 feet beyond the point where the cable system was installed, another length of rope can be spliced on the 3,000 feet at first used, and the system continued indefinitely. The ropes are driven at a speed of 300 feet a minute, and the system has a calculated capacity of 300 tons in ten hours, there being about 40 steel cars, each weighing 1,400 pounds and having a capacity of 2,600 pounds.

"In the south tunnel new air-locks have been installed, the required machinery is under contract, and it is expected that the construction of the tunnel will be resumed in September. The shield, which is being built, is of a new design. It is stiffened by vertical and horizontal frames and by transverse diaphragms, and is provided in front with a movable cantilever working platform which may be protruded beyond the cutting edge if necessary. In the rear are arranged the hydraulic jacks, valves and other mechanism necessary for moving the shields and for operating the erector, which is a diametrical arm concentric with the shield and commanded by hydraulic apparatus. It receives the segments, which have special brackets for connection with it, and sets them in place inside the tail of the shield.

"Since the operations have been resumed, work has progressed actively with the one exception of delay caused in changing and altering the shield. Progress in rock and silt on the work recently executed has been between 4 and 5 feet per day of finished tunnel, built under exceptionally difficult and hazardous conditions, with 65 feet of water and only 10 feet of soft silt over the crown of the tunnel.

"The authority of the New York Department of Docks has been given to occupy surface over the old shaft at the New York end of the tunnel, for construction purposes. A fireproof steel building, 80 feet square, will be erected for the accommodation for workmen and for the installation of the machinery, similar to that on the New Jersey side. The shafts, however, are different, as the one on the New Jersey side is an open one and the headings are reached through horizontal air-locks in the tunnel, while on the New York side, instead of sinking an open shaft, a closed cassion was sunk and access was had to it through a small steel shaft terminating in a T-shaped air-lock at the bottom. This shaft is too small for the new workings and will be torn out and replaced by a larger one with a T-shaped air-lock above the surface. A hoisting cage will be operated inside this shaft for the removal of the excavated material in cars and for taking supplies into the tunnel. This plant will be used for the construction of that portion of the approaches which is to be lined with cast-iron plates, and from it will be driven the river portions of the tunnel to meet the headings from the New Jersey shaft. A second shield similar to the one described is now under construction and will be operated from this plant.

"The tunnel will have a maximum depth of 102 feet below water level. The distance from the tunnel to river bottom varies from 5 to 65 feet, and the tunnel is driven at a grade of about 2 per cent.," rising in both directions from the middle of the river. An electric railway will run through the tunnel, making connections on the New York side, where there will be a large terminal station, with the Metropolitan Street Railway. At the New Jersey end there will be two approaches, one from the Pavonia ferry of the Erie Railroad, and the other from a point near the Hoboken ferries and the station of the Delaware, Lackawanna & Western Railroad. At these points connections will be made with the electric railway system of Northern New Jersey, an extensive suburban territory being thus placed in direct communication with all parts of Manhattan.

THE ENGINEERING INDEX

THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch.

Replacing a Suspension Bridge by a Masonry Arch. Brief illustrated description of special work in replacing a highway bridge crossing the Dordogne River at Argental, in France. 700 w. Eng News—July 16, 1903. No. 56747.

Australia.

Pyrmont Bridge, Sydney, Australia. John Plummer. Illustrations, with brief account of the construction work of this bridge, which has a swing span of 223 ft., and twelve side spans, each of 82 ft. 1000 w. Sci Am Sup—July 11, 1903. No. 56661.

Eye-Bars.

Comparison of Eye-Bar Chains with Steel Wire Cables for the Manhattan Bridge. Extracts from a statement by Mr. Lindenthal on the comparative merits of eye-bar chains and steel wire cables for suspension bridges. 1500 w. Eng News—June 25, 1903. No. 56363.

Wire Cables versus Eye-Bar Chains for Suspension Bridges. Wilhelm Hildenbrand. Gives facts and figures favorable to wire cables and criticises the opinions of Mr. Gustav Lindenthal in regard to the Manhattan bridge. 1800 w. Eng Rec —July 4, 1903. No. 56545.

We supply copies of these articles. See page 958.

Laibach.

A Concrete-Steel Three-Hinged Arch Bridge. Illustrations and particulars of the bridge at Laibach, Austria, taken from an article by Prof. J. Melan in the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereins.* 1800 w. Eng News—July 16, 1903. No. 56749.

Lattice Trusses.

An Exhibit of Some Curious Lattice Trusses. George N. Linday. Gives illustrated study of miniature trusses made to determine their behavior when loaded. General discussion. 4500 w. Jour W Soc of Engrs—June, 1903. No. 56397 D.

Lift Bridge.

Scherzer Rolling-Lift Plate Girder Bridges. An illustrated detailed description of a recently completed bridge at Bridgeport, Conn., carrying four tracks of the N. Y., N. H. & H. R. R. over the Pequonnock River. 1800 w. Eng Rec—July 11, 1903. No. 56643.

Magdeburg.

The Königsbrücke in Magdeburg (Der Bau der Königsbrücke in Magdeburg). O. Peters. An illustrated description of a large ornamental bridge over the Elbe River, with a steel arch from which the highway is suspended, and masonry towers at the ends. 1 Plate. 3000 w. Serial. 2 Parts. Deutsche Bauzeitung—May 30 and June 6, 1903. No. 56181 each D.

Manhattan Viaduct.

Erecting the Manhattan Valley Viaduct. Brief illustrated account of methods adopted to avoid interrupting traffic in a very busy thoroughfare. 700 w. Ir Age—July 30, 1903. No. 56851.

Minneapolis Viaduct.

Failure of a Steel Viaduct at Minneapolis, Minn. A description of the conditions which existed and the cause of the failure. 450 w. Eng News—June 25, 1903. No. 56362.

Prussian Specifications.

Specifications for the Design of Bridges with Steel Superstructure (Vorschriften für das Entwerfen der Brücken mit Eisernem Ueberbau). The official specifications for steel bridges on Prussian government railways. 5000 w. Zentralblatt d Bauverwaltung—June 20, 1903. No. 56218 B.

Railway Bridges.

Railway Bridges. Alexander Ross. Read at the Engng. Con. of the Inst. of Civ. Engrs. Indicates the difficulties that exist in standardizing railway practice in respect of loads on bridges up to 200-ft. span. 1500 w. Engng—June 19, 1903. No. 56315 A.

Suspension Bridge.

A Semi-Rigid Suspension Bridge over the Rhone, at Vernaison, France (Pont Suspendu Semi-Rigide de Vernaison, Rhône). Ch. Dantin. Illustrated description of a highway suspension bridge, of 232 meters span, with low stiffening trusses, near Lyons. 1 Plate. 1600 w. Génie Civil—July 4, 1903. No. 56917 D.

Suspension Bridge at Vernaison. Illustrates and describes a bridge recently constructed over the Rhone. 700 w. Engr, Lond—July 17, 1903. No. 56816 A.

Transfer Bridge.

A Transfer Bridge with a Span of 400 Meters (Transbordeur de 400 Mètres de Longeur). An illustrated description of a hinged-arch bridge, from which is suspended a car, for transporting passengers and vehicles across the Gironde River, at Bordeaux, France. 1 Plate. 1500 w. Génie Civil—June 20, 1903. No. 56913 D.

Tyne.

New High Level Bridge Over the Tyne. Illustrates and describes a new railway bridge under construction at Newcastle. 1800 w. Transport—July 3, 1903. No. 56559 A.

Uganda.

The American Invasion of Uganda. Joseph M. Rogers. An illustrated account of the twenty-seven American bridges, built on the Uganda Ry. and interesting features of the construction work. Also gives brief review of conditions in this section of Africa, and historical events of interest. 3200 w. Rev of Revs—July, 1903. No. 56349 C.

CANALS, RIVERS AND HARBORS.

Aar River.

The Water Power Development of the Hydro-Electric Plant at Wangen-on-the-Aar, Switzerland (Ueber die Wasserbauten des Elektrizitätswerkes Wangen a. d. Aare, Schweiz). R. Schmick. An illustrated description of the construction of a movable dam, a canal and other work for water power development on the Aar River. Serial. 2 Parts. 3500 w. Deutsche Bauzeitung—June 20 and 27, 1903. No. 56182 each D.

Alps.

The Water Powers on the Northern Slopes of the Alps (Die Wasserkräfte am Nordabhange der Alpen). Dr. Oskar von Miller. An account of the available water powers on the rivers flowing from the northern slopes of the Alps in Switzerland, Austria and particularly, in Bavaria, with maps and tables. 4000 w. Zeitschr d Ver Deutscher Ing—July 11, 1903. No. 56240 D.

Belfast.

Belfast Harbor and Its Development. G. F. L. Giles. Read before the Inst. of Nav. Archts. Maps and description, with

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information concerning each of the important docks. 2000 w. Engng—July 17, 1903. No. 56821 A.

Buenos Aires.

The Harbor of Buenos Aires and the La Plata River (Der Hafen von Buenos Aires und seine Zukunft im Zusammenhang mit dem La Plata). C. Offermann. A description of the La Plata River and the improvement of the harbor of Buenos Aires, Argentina. Map. Serial. 2 Parts. 7000 w. Zentralblatt d Bauverwaltung—April 15 and 18, 1903. No. 56209 each B.

Canals.

Ship Canals (Seekanäle). Hr. Eger. A general review of the ship canals of the world, both built and projected, with tables of statistics. Serial. 2 Parts. 3500 w. Zentralblatt d Bauverwaltung—May 16 and 20, 1903. No. 56214 each B.

Charles River.

A Study of the Geology of the Charles River Estuary and Boston Harbor, with Special Reference to the Building of the Proposed Dam Across the Tidal Portion of the River. W. O. Crosby. Investigations made to learn how far these channels had their origin in tidal scour, and to learn the character of the ground on which the dam would have to be built. 13000 w. Tech Quar—June, 1903. No. 56387 E.

Core Walls.

Macadam as a Core for Dams and Reservoir Embankments. Editorial on the advantages of this material for the uses named, its cost being less than concrete. 1200 w. Eng News—June 25, 1903. No. 56360.

Corinth.

The Corinthian Canal. Frank W. Jackson. Brief historical account of this undertaking, with discussion of reasons why it has not proved commercially successful. Ill. 1500 w. Sci Am Sup—July 25, 1903. No. 56792.

Dams.

A High Masonry Dam in Germany. Illustrations and brief description of an unusually high dam being built across the small river Urft. 700 w. Eng News—July 16, 1903. No. 56750.

The Great Goose Creek Dam for the Denver Water Supply. An illustrated description of one of the most notable dams in the world, having a height of 231 ft., and, when filled, impounding about 30,000,000,000 gallons of water. 700 w. Sci Am—July 4, 1903. No. 56466.

An Interesting Test of an Unfinished Arch Dam. Describes the Six-Mile Creek Dam of the Ithaca Water-Works Company, and gives a report of the test by a flood before the dam was completed. Ill. 900 w. Eng Rec—July 18, 1903. No. 56737.

The Failure of the Oakford Park and Fort Pitt Dams, Near Jeannette, Pa. Willis Whited. Brief illustrated account of these two disasters. 1000 w. Eng News—July 23, 1903. No. 56843.

Dover.

The New Harbor Works at Dover. Harold J. Shepstone. An illustrated description of this important engineering work on the south coast of England. 1800 w. Sci Am Sup—June 27, 1903. No. 56355.

Dredging.

Dredging in New South Wales. Cecil West Darley. Read at Engng. Con. of the Inst. of Civ. Engrs. On the extensive river improvement that conditions have made necessary and the dredges used. 1200 w. Engng—June, 1903. No. 56318 A.

Dredging, with Special Reference to Rotary Cutters. James Henry Apjohn. Read at Engng. Con. of the Inst. of Civ. Engrs. Describes dredges used for dredging clay. 1000 w. Engng—June 19, 1903. No. 56319 A.

Emscher River.

The Improvement of the Emscher River (Verbesserung der Vorflut im Emschergebiet). Hr. Middeldorf. A paper before a Dortmund mining society, describing the unsatisfactory conditions in the valley of the Emscher, Westphalia, and giving plans for improving the current flow and the sanitary condition of the stream. 2 Plates. 2500 w. Glückauf—June 27, 1903. No. 56294 D.

Erie Canal.

The Erie Canal—Its Past and Future. M. M. Wilner. Gives an account of the proposed enlargement, reviews the past history, and discusses the outlook and New York's industrial position. Ill. 4700 w. Rev of Revs—July, 1903. No. 56350 C.

Floating Docks.

See Marine and Naval Engineering.

Floods.

The Recent Mississippi Floods and Their Relation to the Levees. T. G. Dabney. Extracts from a manuscript report on the high water of 1903 made to the Mississippi River Commission. 2000 w. Engng News—July 9, 1903. No. 56651.

The Heppner Disaster. John T. Whistler. Copy of a report made to the U. S. Geol. Survey. An account of a destructive storm causing great loss of life and property. 1800 w. Eng News—July 16, 1903. No. 56746.

Foreshores.

Foreshore Protection and Travel of Beaches. William Tregarthen Douglass. Read at the Engng. Con. of the Inst. of Civ. Engrs. Discusses points of impor-

We supply copies of these articles. See page 958.

tance in sea-defence. 1400 w. Engng—June 19, 1903. No. 56316 A.

Forth-Clyde.

Proposed Forth-Clyde Ship Canal. Information, by David Alan Stevenson, in regard to this proposed deep-water canal across Scotland. Map. 2000 w. U S Cons Repts, No. 1705—July 24, 1903. No. 56798 D.

Hydro-Electric Plants.

See Electrical Engineering, Generating Stations.

India.

Notes on the Ports and Harbors of Peninsular India. Horace Bell. Showing the need for more ports in India, and discussing the difficulties. 3200 w. Jour Soc of Arts—July 17, 1903. No. 56803 A.

Kiel Canal.

The Kaiser Wilhelm Canal and Its Operation (Der Kaiser Wilhelm-Kanal und Seine Bisherigen Betriebsergebnisse). Josef Riedel. An illustrated description of this ship canal between the North Sea and the Baltic, and account of its operation, with statistics of traffic. Tables. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 4, 1903. No. 56268 D.

Needle Dam.

The Reconstruction of a Needle Dam on the Fulda River, Germany (Wiederherstellung eines Nadelwehres an der Fulda). Julius Greve. An illustrated description of repair work on a needle dam built to improve the navigation of the Fulda. 2400 w. Zentralblatt d Bauverwaltung—April 29, 1903. No. 56211 B.

Panama Canal.

A Colombian View of the Panama Canal Question. Raul Pérez. A statement of the case. 2500 w. N Am Rev—July, 1903. No. 56351 D.

Sea Wall.

The Galveston Sea Wall. An illustrated description of structures at Galveston, Tex. The concrete wall is protected by a mass of heavy granite rip rap and backed by an earth fill to the level of the top of the wall, and formed into a driveway about 70 ft. wide. 2000 w. Eng Rec—July 4, 1903. No. 56543.

Water Hyacinth.

Destroying the Water Hyacinth by a New Chemical Process. Describes a method now being tried for ridding southern rivers of this troublesome growth, which seems to give promise of success. 900 w. Sci Am—July 4, 1903. No. 56463.

CONSTRUCTION.

Concrete Building.

The Erection of a Tall Concrete Office Building. An illustrated description of the construction of the Ingalls building, in Cincinnati. 4000 w. Eng Rec—July 18, 1903. No. 56734.

Concrete Coping.

Some Hints on Making Concrete Coping. Indicates how good looking and yet inexpensive concrete coping may be made. 800 w. Eng News—July 9, 1903. No. 56653.

Drilling.

Experience in Diamond Drill Work on the Deep Waterways Survey. Information from the Report of the Board of Engrs. on Deep Waterways, giving reliable data of costs of drilling 25 holes each averaging about 100 ft. deep. 2000 w. Eng News—July 23, 1903. No. 56845.

Fireproof Construction.

Building Construction from a Fire Brigade Officer's Point of View. Arthur Pordage. Read before the International Fire Congress. Showing that construction called "fireproof" often adds to the danger, and discussing accepted theories in regard to fireproof materials. Short discussion. 4000 w. Builder—July 11, 1903. No. 56673 A.

How to Make Existing London Buildings More Fire-Resisting. Max Clarke. Read before the International Fire Congress. Deals with constructional details. 2700 w. Builder—July 11, 1903. No. 56674 A.

Framework.

Contribution to the Theory of Framework Structures (Beitrag zur Theorie des Räumlichen Fachwerks). Prof. Th. Landsberg. A graphical and mathematical discussion of the stresses in frameworks in three dimensions. Serial. Part 1. 2000 w. Zentralblatt d Bauverwaltung—May 6, 1903. No. 56212 B.

Hudson Tunnel.

The Hudson River Tunnel. Reviews the history of this undertaking from its commencement in 1874, and gives an illustrated account of the preparations to complete the work. The tunnel will cross from the foot of 15th St., Jersey City, to the foot of Morton St., N. Y. 3800 w. Eng Rec—July 25, 1903. No. 56839.

Pile Driving.

Why the Nasmyth Steam Hammer Has Not Displaced the Friction-Clutch Pile Driver. Editorial showing how small a part of the working day is spent in actual driving, and suggesting needed improvements in methods of handling the piles, etc., and other details to secure economy. 1000 w. Eng News—July 2, 1903. No. 56415.

Piling.

The Calculation of Piling (Zur Berechnung der Bohlwerke). Prof. H. Engels.

An illustrated description of experiments with wooden stakes driven into sand, and a mathematical discussion of the results as applied to piling and similar work. 2500 w. Zentralblatt d Bauverwaltung—June 3, 1903. No. 56216 B.

Reinforced Concrete.

A Five Story Machine Shop of Reinforced Concrete. Illustrates and describes the interesting building, and method of erection, now in progress in Philadelphia, for Mr. Hugo Bilgram. 900 w. Am Mach—July 2, 1903. No. 56419.

Roads.

The United States Road Material Laboratory. Logan Waller Page and Allerton S. Cushman. Read before the Am. Soc. for Test. Materials. Historic review of road material tests; the present article is devoted principally to the methods in use in France. Ill. 2300 w. Eng Rec—July 25, 1903. Serial. 1st part. No. 56840.

Tarred Roads in America. Information concerning tar-macadam roads as shown in Ontario and from other sources, with cost, work of construction, etc. Ill. 2800 w. Automobile—July 11, 1903. No. 56607.

Notes on Some Moderate Cost Roads. William G. Raymond. Describes roads recently constructed, near Troy, N. Y., giving the contract prices for building. Ill. 1500 w. Eng Rec—July 18, 1903. No. 56736.

Simplon Tunnel.

The Construction of the Simplon Tunnel (Der Bau des Simplontunnels). C. J. Wagner. A general review of the progress of work on this great tunnel through the Alps, from Jan. 1, 1901, to Jan. 1, 1903, with illustrations and tables. Serial. 2 Parts. 1 Plate. 9000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 13 and 20, 1903. No. 56266 each D.

Steel Structures.

Specifications for Material and Workmanship for Steel Structures. T. L. Condron. Gives diagram, showing the variations in the physical and chemical requirements, and submits specifications based upon steel having an average tensile strength of 62,000 lbs. per sq. in., with discussion. 12800 w. Jour W Soc of Engrs—June, 1903. No. 56396 D.

Temporary Buildings.

Minimizing the Risk of Fire in Temporary Buildings. T. W. Aldwinckle. Read at meeting of the Incor. Assn. of Munic. & Co. Engrs. Describes the ordinary temporary building, and considers what steps may be taken to minimize the fire risk. 3000 w. Builder—July 11, 1903. No. 56675 A.

MATERIALS.

Asphalt.

Asphalt Rock in Kentucky. William E. Burk. Locates and describes these deposits. Map. 1200 w. Eng & Min Jour—June 27, 1903. No. 56442.

Bitumen.

The Testing of Bitumen for Paving Purposes. A. W. Dow. Abstract of a paper read before the Am. Soc. for Test. Materials. Briefly describes the construction of one class of asphalt pavement, discussing its properties, and gives tests devised by the writer for the determination of these properties. 2500 w. Eng Rec—July 11, 1903. No. 56644.

Cement.

A Study of the Constitution of Hydraulic Cements (Etude sur la Constitution des Ciments Hydrauliques). S. B. Newberry and Melville M. Smith. Chemical and physical examinations of Portland and other cements. 5000 w. Bull Soc d'Encou—May 31, 1903. No. 56929 G.

Portland Cement in Germany. Reports the production as far exceeding the demand, and gives information in regard to consumption, etc. 700 w. U S Cons Repts, No. 1691—July 8, 1903. No. 56-498 D.

Portland Cement Manufacture: the Raw Materials. Edwin C. Eckel. Discusses the character of the raw materials available, and the proportions of the mixture. 1600 w. Munic Engng—July, 1903. No. 56385 C.

Soundness Tests of Portland Cement. W. P. Taylor. Read before the Am. Soc. of Testing Materials. An illustrated article reviewing methods of testing for determining soundness, and explaining some of the causes of unsoundness. 3000 w. Eng News—July 23, 1903. No. 56844.

Testing the Soundness of Cement. Frederick W. Taylor, and Sanford E. Thompson. Considers the methods advocated by the Committee of the Am. Soc. of Civ. Engrs., and outlines several other methods. 3000 w. Am Arch't—July 18, 1903. No. 56744.

Cement Works.

The Plant of the Hudson Portland Cement Co., at Hudson, N. Y. An illustrated detailed description of a plant using limestone and shale or clay as raw materials, now being built. The rotary kiln dry process. 2200 w. Eng News—July 23, 1903. No. 56841.

The Works of the St. Louis Portland Cement Company, Prospect Hill, Mo. John E. Conzelman. An illustrated detailed description of a modern plant for the manufacture of Portland cement by the dry process. 3500 w. Eng Rec—July 11, 1903. No. 56642.

We supply copies of these articles. See page 958.

Clay.

Effect of Fineness of Grain on the Fusibility of Clay. Heinrich Ries. A brief report of experiments showing that the size of grain exerts a marked influence on the point of fusion. 700 w. Trans Am Inst Min Engrs—Feb., 1903. No. 56764.

Concrete.

The Merits of Rubble Concrete. Editorial discussion of the advantages and disadvantages of concrete, concluding that except in places where cut stone would be used, concrete has no economic advantage over stone masonry. Shows the value of rubble concrete when great strength is required. 1200 w. Eng News—July 16, 1903. No. 56748.

Reinforced Concrete.

The Theory of Reinforced-Concrete Construction (Theorie der Betoneisen-Konstruktionen). E. Mörsch. An address before the "Deutscher Betonverein," giving a general discussion of concrete-iron construction and its principles. Diagrams. 5000 w. Serial. 3 Parts. Deutsche Bauzeitung—April 25, May 2 and 6, 1903. No. 56180 each D.

Applications of the Hennebique System of Reinforced-Concrete Construction in Hydraulic Works (Anwendung von Betoneisen (System Hennebique) im Wasserbau). A. v. Horn. An illustrated description of quay walls and structures in and under water, built of reinforced concrete. 1 Plate. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 27, 1903. No. 56267 D.

A Graphostatical Investigation of Compound Bodies of Concrete and Iron (Graphostatische Untersuchung der Verbundkörper aus Beton und Eisen). Robert Bortsch. A theoretical graphical discussion of the stresses in steel-concrete structures. 1 Plate. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 4, 1903. No. 56269 D.

Timber Seasoning.

See Railway Engineering, Permanent Way.

MEASUREMENT.

Precise Level.

The New Coast and Geodetic Survey Precise Level: A Possible Successor of the Wye Level. John F. Hayford. An illustrated description of the instrument and its manipulation, with report of its use in actual service. 3500 w. Eng News—July 2, 1903. No. 56413.

Soundings.

Rapid River Soundings on the Survey of the Danube. Brief description of a method used by the Austrian government engineers. 900 w. Eng News—July 16, 1903. No. 56752.

Stereoscopic Measurer.

A Stereoscopic Instrument for Measuring Distances in Hydrographical Surveys (Ueber Stromsondierungen). Karl Grünhut. An illustrated description of a binocular instrument by which the distance to an object can be readily determined from a boat or any other place. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—July 4, 1903. No. 56270 D.

Surveying Instruments.

Note Concerning an Old Instrument for Finding Distances, Exhibiting the Oldest Known Form of the Transit-Theodolite Principle. H. D. Hoskold. Illustrations and information concerning early devices for the object under consideration. 4000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 56768 C.

MUNICIPAL.

Civil Engineers.

The Civil Engineer and His Work in Small Cities. J. S. Humphrey. Considers the varied demands made upon a city civil engineer. 2500 w. Pro Indiana Engng Soc—1903. No. 56772 D.

Dresden Exposition.

The German Municipal Exposition in Dresden (Die Deutsche Städte-Ausstellung in Dresden). J. O. Knoke. A general review of this exhibition of engineering and other features of modern cities. 4000 w. Zeitschr d Ver Deutscher Ing—July 4, 1903. No. 56238 D.

The German Municipal Exposition at Dresden (Deutsche Städteausstellung in Dresden). An illustrated account of an exhibition of the various engineering and other features of modern cities. Serial. Part 1. 700 w. Zentralblatt d Bauverwaltung—June 6, 1903. No. 56217 B.

Fire-Engine House.

The New Barracks of the Paris Firemen (La Nouvelle Caserne de Sapeurs Pompiers). M. Marchand. A well-illustrated description of engine-house, barracks and apparatus for fire fighting in Paris. 1 Plate. 2500 w. Génie Civil—June 6, 1903. No. 56909 D.

New Orleans Drainage.

See Electrical Engineering, Power Applications.

Pavements.

Improved Streets and Their Repairs. W. F. Raymond. Discusses repairs to asphalt, brick, granite block, wooden block, bituminous macadam, and pavements generally. 2200 w. Munic Engng—July, 1903. No. 56386 C.

Refuse Disposal.

The Use of Refuse in Agriculture (Ueber die Landwirtschaftliche Verwertung des Mülls). Dr. Wilsing. A dis-

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cussion of the use of refuse and garbage for manuring purposes. 3000 w. Gesundheits-Ingenieur—May 20, 1903. No. 56198 B.

River Pollution.

On the Pollution of Our Rivers. Charles Milnes Gaskell. Reviews the history of the rivers of Great Britain, and the action against river pollution; what has been accomplished, and what remains to be done. 6300 w. Nineteenth Cent—Juiy, 1903. No. 56671 D.

Stream Pollution and Remedial Policy. M. O. Leighton. Considers the natural pollution due to the land being occupied, the household sewage and refuse, and the wastes from industries, discussing the limitations which should obtain in all requirements even while aiming at improvements. 3000 w. Pro Indiana Engng Soc—1903. No. 56773 D.

Sewerage.

The Sewerage System of the Old Part of Magdeburg (Die Kanalisation der Altstadt von Magdeburg). An illustrated description of the new system of sewers installed in this German city, on the Elbe River. Serial. Part 1. 2800 w. Zentralblatt d Bauverwaltung—March 21, 1903. No. 56207 B.

Bacterial Treatment of Water and Sewage Up to Date. Dr. Percy Frankland. Read before the Engng. Con. of the Inst. of Civ. Engrs. Introductory to a discussion. Names the points most desirable to consider; the relative merits of different methods, contact beds, effluents, storm water, etc. 1800 w. Engr, Lond—July 10, 1903. No. 56696 A.

The Composition of Sewage in Relation to Problems of Disposal. George W. Fuller. Gives a review of the progress in this field, the prevailing methods of disposal, and especially the dilution method and modes of treatment preparatory to filtration. 9800 w. Tech Quar—June, 1903. No. 56389 E.

Northwestern Avenue Sewer, Indianapolis. Walter Buehler. An illustrated detailed description of interesting construction work. 3500 w. Pro Indiana Engng Soc—1903. No. 56771 D.

Sidewalks.

Sidewalk Building and Sidewalk Grades in Small Towns. Ernest McCullough. An account of experience of a small town, with report of the work as finally carried out by the writer. 2300 w. Eng News—July 9, 1903. No. 56652.

Stray Currents.

See Street and Electric Railways.

Trackways.

Trackways for Streets (Strassengleise). A. H. Weicht. Illustrated descriptions of flat steel trackways, of various sections, for street traffic. 4000 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 12, 1903. No. 56228 D.

WATER SUPPLY.

Cincinnati.

Notes on Progress of Cincinnati's New Water Works. C. N. Miller. An illustrated report of the progress made on these extensive new works. 2400 w. Eng Rec—July 4, 1903. No. 56542.

High Pressure.

Philadelphia's High Pressure Fire Pipe Line. An illustrated account of this recently installed line to protect the "congested district," with report of its trial. 1000 w. Sci Am—July 11, 1903. No. 56657.

India.

Famines and Their Results. Reports results of some of the irrigation works, giving illustrations of reservoirs, and especially an account of Kathiawar. 1200 w. Engr, Lond—July 17, 1903. No. 56812 A.

Ozone.

The Sterilization of Water by Means of Ozone (Stérilisation de l'Eau par l'Ozone). Dr. Ed. Imbeaux. General illustrated historical and descriptive review. Serial. 2 Parts. 4500 w. Rev Technique—June 25 and July 10, 1903. No. 56925 each D.

Shrewsbury, Eng.

Shrewsbury Water Supply. A brief illustrated account of a recently installed pumping plant of novel description. 1100 w. Engr, Lond—June 19, 1903. No. 56328 A.

Sterilization.

The Sterilization of Water (Die Wassersterilisation). Dr. Schüder. A general review of water purification and methods of removing injurious bacteria. 4000 w. Gesundheits-Ingenieur—June 10, 1903. No. 56199 B.

Syracuse, N. Y.

Syracuse Water Works. A review of their history from 1841 to 1902. Ill. 3000 w. Fire & Water—June 27 & July 4, 1903. Serial. 2 Parts. No. 56364.

Tall Buildings.

Water Supply of Tall Buildings. George W. Nistle. Especially considers conditions at Chicago, suggesting the drilling of wells far enough to get uncontaminated water. Discusses methods of delivery and piping, the arrangements for ice cold water, and hot water. 2800 w. Dom Engng—June 25, 1903. No. 56367 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Automatic Telephony.

The Mix & Genest Automatic Telephone Sub-Station System (Neue Automatische Fernsprechnebenstellensysteme Mix & Genest, Berlin). Dr. L. Rellstab. A paper before the Elektrotechnischer Verein, giving an illustrated description of an automatic system for private branch telephone exchanges, with discussion. Serial. 2 Parts. 3000 w. Elektrotech Zeitschr—July 2 and 9, 1903. No. 56-255 each B.

An Automatic Telephone Exchange for Chicago. R. E. Sack. Illustrates and describes the interesting exchange of the Illinois Telephone & Telegraph Co. 3000 w. Elec Wld & Engr—July 4, 1903. No. 56540.

The Faller Mechanical Telephone Operator. Frank C. Perkins. An illustrated description of the interesting invention of Ernest A. Faller, with its recent improvements, and data of interest. 2500 w. Elec Engr, Lond—June 19, 1903. No. 56336 A.

Exchange.

The Telephone Exchange of the Manmattan Railway Company. Brief illustrated description of a private exchange for intercommunication with its numerous stations, yards and terminals, having no outside connections. 1000 w. Elec Rev, N. Y.—June 27, 1903. No. 56444.

Utica Home Telephone Company's Exchange. F. L. Martin. An illustrated detailed description of construction work consisting of an office building, a complete underground system, cable and aerial system, including the installation of the central office and subscriber's sub-station equipment. 2800 w. Elec Wld & Engr—July 18, 1903. No. 56738.

Pacific Cable.

Completion of the First American Pacific Cable. Map showing the route from San Francisco to Manila, with information of interest concerning this recently completed work. 1400 w. Elec Wld & Engr—July 11, 1903. No. 56641.

Selector.

The Rodary Selective Signaling System on the Paris-Lyons-Mediterranean Railway (Applications du Rappel Bréguet-Rodary aux Communications Télégraphiques et Téléphoniques sur les Chemins de Fer de P. L. M.). M. Rodary. Illustrated description of a selective call applied to telegraph and telephone stations on a railway. 2000 w. Rev Gén Chemins de Fer—June, 1903. No. 56-941 H.

Space Telegraphy.

Hertzian Wave Telegraphy. Dr. Fleming's second paper, dealing with transmitting arrangements and transmitters. Ill. 3200 w. Sci Am Sup—July 11, 1903. No. 56664.

Hertzian Wave Telegraphy. Dr. Fleming's third paper, dealing with receiving arrangements and receivers. Ill. 4200 w. Sci Am Sup—July 18, 1903. No. 56678.

Hertzian Wave Telegraphy. Dr. Fleming's fourth paper discussing the question of wireless telegraphy in view of the problem of privacy. Ill. 3700 w. Sci Am Sup—July 25, 1903. No. 58793.

Electrical Syntony and Wireless Telegraphy. Nevil Maskelyne. An account of the interference in connection with the experimental lecture of Prof. Fleming at the Royal Institution. Also gives reprint of letters from Dr. Fleming and the author as published in the London *Times*. 4000 w. Elect'n, Lond—June 19, 1903. No. 56338 A.

The Lodge-Muirhead System of Wireless Telegraphy. Maurice Solomon. Illustrates some of the instruments and discusses features of this system. 2500 w. Nature—July 16, 1903. No. 56830 A.

Wireless Telegraphy. Edmund A. N. Pochin. Read before the Engng. Con. of the Inst. of Civ. Engrs. Brief consideration of syntonic and optical methods of securing isolation. General discussion. 4500 w. Elec Engr, Lond—June 26, 1903. No. 56478 A.

Wireless Telegraph Systems at Martinique. Emile Guarini. An illustrated article concerning the wireless station recently established to give the island means of communication in case of dangerous manifestations of Mont Pelée. 1000 w. Elec, N. Y.—July 22, 1903. No. 56745.

Telephony.

The Telephone and the Technical School. J. C. Kelsey. Read before the convention of the Ind. Tel. Assn. of the U. S. Urging that a telephone course that will be of benefit to the industry be established in the universities. 1500 w. Elec Rev, N. Y.—July 11, 1903. No. 56632.

Telephotography.

The Transmission of Photographs by Telegraph (Sur la Transmission de Photographies à l'Aide d'un Fil Télégraphique). M. Korn. An illustrated description of a telephotographic apparatus, including a selenium resistance at the transmitter and a vacuum tube discharge, varied by the line current, at the receiver.

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400 w. Comptes Rendus—May 18, 1903. No. 56946 D.

Tuned Transmitter.

The Production of Alternating Currents by a Microphone Transmitter (Ueber die Erregung von Wellenströmen durch eine Mikrophonanordnung). R. v. Lieben and E. Reisz. A description of a method of exciting alternating currents of a definite frequency by meaus of a small iron plate attached to a microphone and in inductive relation to the microphone current. Diagrams. 600 w. Elektrotech Zeitschr—June 25, 1903. No. 56250 B.

DISTRIBUTION.

Boosters.

On Boosters. G. Stephens. Considers the conditions under which batteries are worked, and the methods of connecting the booster, etc. Ill. 2000 w. Elec Engr, Lond—July 3, 1903. No. 56566 A.

Conduits.

Moisture in Conduits. W. H. F. Murdock. Calls attention to some of the difficulties in wiring, especially in damp places. 1200 w. Elect'n, Lond—July 10, 1903. No. 56721 A.

Local Power.

Local Distribution of Transmitted Power. George C. Holberton. Read at Con. of Pacific C. Elec. Trans. Assn. Discusses how the best results may be obtained. 2700 w. Jour of Elec—July, 1903. No. 56614 C.

Mains.

Systems of Mains Laying. F. H. Davies. A detailed consideration of subways, conduit systems, pipe systems, cables laid direct in the earth, and solid systems. 3500 w. Elec Engr, Lond—June 19, 1903. No. 56335 A.

Monocyclic Current.

Monocyclic Current from Three-Phase System. F. Hardie Jeannin. Describes the situation and the scheme resorted to by the writer. Ill. 1000 w. Am Elect'n —July, 1903. No. 56637.

Safety Devices.

Notes on the Construction of Electric Safety Devices for Weak-Current Installations (Beitrag zur Konstruktion Elektrischer Sicherungen für Schwachstromanlagen). Hans Carl Steidle. A description, with diagrams, of lightning protectors, fuses and other protective devices for telephone and telegraph plants. 2500 w. Elektrotech Zeitschr—July 2, 1903. No. 56254 B.

Single-Phase.

Transmission and Distribution by Single-Phase Alternating Current. E. W. Monkhouse. Showing the advantages of this system. Short general discussion. 2000 w. Elect'n, Lond—June 26, 1903. No. 56483 A.

Submarine Cables.

Some Points Relating to Submarine Electric Power Cables. G. U. G. Holman. Refers to lessons taught by interruptions of service on the submarine power cable belonging to the Canadian Electric Light Co., which is laid on the bed of the St. Lawrence River. 1600 w. Can Engr—July, 1903. No. 56506.

Sub-Stations.

Notes on Sub-Station Practice. On the proper location, design and operation of sub-stations for railway service. 2500 w. St Ry Jour—July 4, 1903. No. 56533 D.

Switchgears.

The Design of Extra High Tension Switchgears. W. E. Warrilow. Begins an illustrated description of recent designs showing the developments which have resulted from experience. 1700 w. Elec Engr, Lond—July 3, 1903. Serial. 1st Part. No. 56567 A.

ELECTRO-CHEMISTRY.

Accumulators.

Manufacture of Electrical Accumulators. A copy of the draft regulations which have been issued under the Factory and Workshop Act, 1901, in England. 1500 w. Elec Rev, Lond—June 26, 1903. No. 56482 A.

The Principles and Care of Accumulators. Horace M. Wyatt. Considers the ways in which an accumulator may be damaged, and why they affect the plates. Ill. 2000 w. Autocar—June 20, 1903. No. 56346 A.

See also Electrical Engineering, Generating Stations; and Streets and Electric Railways.

Chlorine Smelting.

Chlorine Smelting, with Electrolysis. James Swinburne. A discussion of a new process covering a wide domain in metallurgy comparing with present processes, and considering cost, etc. 2800 w. Elect'n, Lond—July 10, 1903. Serial. 1st Part. No. 56720 A.

Diamonds.

The Production of Diamonds in the Electric Furnace. C. L. Durand. Describes the work of Prof. Henri Moissan in this field, illustrating the furnace used. 2500 w. Elec Rev, N. Y.—June 27, 1903. No. 56443.

Dielectrics.

The Heat of a Change in Connection with Changes in Dielectric Constants and in Volumes. C. L. Speyers. Gives an account of experimental investigations

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with a study of results. 4500 w. Am Jour of Sci—July, 1903. No. 56381 D.

Electrolysis.

The Present Position of the Theory of Electrolysis. W. C. Dampier Whetham. Read before the Faraday Society. Reviews the early investigations made which establish the convective view of electrolysis, gives arguments supporting the dissociation theory, and an experimental study of the phenomena of electrolysis and the osmotic properties of electrolysis. 7500 w. Elektrochem & Met—July 1, 1903. No. 56568 A.

Fluorine.

Production of Fluorine in Moissan's Electrolytic Apparatus. Illustrates the electrolytic apparatus used, explaining how the gas is obtained in a pure state. 800 w. Sci Am—July 4, 1903. No. 56464.

Garuti Process.

The Garuti Process of Generating Oxygen and Hydrogen. Emile Guarini. An illustrated description of the apparatus of Dr. Pompes Garuti for the electrolytic production of oxygen and hydrogen. 1200 w. Sci Am Sup—June 27, 1903. No. 56356.

Lead Refining.

Electrolytic Lead-Refining. Anson G. Betts. Describes a successful process using a solution of lead-fluosilicate, containing an excess of fluosilicic acid, as an electrolyte. Ill. 3000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 56761.

Nitric Acid.

The Production of Nitric Acid by Means of Electric Discharges (Sur la Production de l'Acide Nitrique par Décharges Electriques). J. de Kowalski. A description of a process for extracting nitrogen, which then forms nitric acid, from the atmosphere by means of electric discharges, a discussion of the theory, and a review of other similar processes. 2500 w. Bull Soc Internat d Electriciens—June, 1903. No. 56939 H.

ELECTRO-PHYSICS.

Crookes Tube.

On the Properties of the Field Surrounding a Crookes Tube. Arthur W. Goodspeed. Reprinted from *Pro. Am. Phil. Soc.* An account of investigations suggested by radiographic records below the plate. 2800 w. Sci Am Sup—June 27, 1903. No. 56357.

Electrode Voltage.

Electrode Voltage of Electrode Potential. Woolsey McA. Johnson. An explanation of this term is given. 1800 w. Electro-Chem Ind—July, 1903. No. 56-512 C.

Matter.

Modern Views on Matter. Sir Oliver Lodge. The Romanes Lecture, delivered in the Sheldonian Theatre, Oxford, June 12, 1903. Contains much information of interest to students of electro-physics. 7000 w. Pop Sci M—Aug., 1903. No. 56822 C.

Modern Views on Matter. The Realization of a Dream. Sir William Crookes. Address before the Congress of Applied Chemistry, at Berlin. Discussing the latest views as to the constitution of matter. 6000 w. Sci Am Sup—July 11, 1903. No. 56663.

Radiography.

The New Radiations—Cathode Rays and Roentgen Rays. A. Dastre. Translated from the *Revue des Deux Mondes* for the Smithsonian Report. An examination of recent views on the radioactivity of matter. 8000 w. Sci Am Sup—July 4, 1903. No. 56467.

Stereoscopic Radiography (La Radioscopie Stéréoscopique). P. Villard. An illustrated study of Röntgen-ray apparatus, particularly those for securing stereoscopic views. 3000 w. Bull Soc d'Encour—June 30, 1903. No. 56931 G.

Radium and Its Lessons. Sir Oliver Lodge. Summarizes the facts established thus far in regard to this substance, discussing how they are to be accounted for, and giving suggestions for investigations. 3500 w. Nineteenth Cent—July, 1903. No. 56670 D.

Radium and Its Recent Development. From the French of Prof. Cyr. Wattiez, in *L'Industrie Textile*. A review of what is known of this substance and its peculiar properties. 2800 w. Sci Am Sup—July 25, 1903. No. 56794.

The Properties of Radium. Abstract of a lecture at the Royal Inst., London, by M. Curie, the discoverer of radium. 1800 w. Mech Engr—June 27, 1903. No. 56-474 A.

Rays Emitted by a Welsbach Burner, which Pass Through Metals, Wood, etc. (Sur l'Existence, dans les Radiations Emises par un Bec Auer, de Rayons Traversant les Metaux, le Bois, etc.). R. Blondlot. Account of experiments, with radiographs. 700 w. Comptes Rendus—May 11, 1903. No. 56943 D.

GENERATING STATIONS.

Aar River.

See Civil Engineering, Canals, Rivers and Harbors.

Accumulators.

Storage Batteries on Electric Railways. Howard S. Knowlton. Explains the construction and installation of the storage battery, and its functions in the power house or on the line with "booster" service. 3000 w. The Engineering Magazine—Aug., 1903. No. 56903 B.

See also Street and Electric Railways.

We supply copies of these articles. See page 958.

Alternators.

Alternating Current Generators and Synchronous Motors. George T. Hanchett. Explains the construction of these machines. Ill. 2000 w. Cent Sta—July, 1903. No. 56605.

Asynchronous Machinery.

Compounded Asynchronous Machinery. G. Hooghwinkel. Briefly explains the difference between synchronous and asynchronous machines, and states the advantages of a compounded and self-exciting asynchronous alternator, describing the struction. 1700 w. Elec Rev, Lond—July 17, 1903. Serial. 1st Part. No. 56806 A.

British Statistics.

Some Statistics of Electricity Supply. J. P. Smith. A review of the progress of the last seven or eight years, giving statistics, and favoring municipal undertakings, claiming they show lower capital expenditure, lower working costs, and lower tariffs. Also discussion. 7500 w. Elect'n, Lond—July 17, 1903. No. 56808 A.

Caspian Oil Wells.

Power Transmission Plant of the Apscheron Electric Co., of Baku (Kraftübertragungsanlage der Apscheroner Elektrizitäts-Gesellschaft Baku). A description of a three-phase central station and power transmission plant for boring and operating oil-wells on the Apscheron peninsula, near Baku, on the Caspian Sea. 1600 w. Elektrotech Rundschau—July 15, 1903. No. 56206 D.

Condensing Plant.

See Mechanical Engineering, Steam Engineering.

Design.

The Design of Electric Stations (Ueber die Ausführung von Elektricitätswerken). E. Wikander. A paper on the general design and planning of electric stations, their location, size, arrangement, etc. 2500 w. Elektrotech Zeitschr—July 2, 1903. No. 56253 B.

Direct Current.

The Experimental Investigation of Direct-Current Dynamos (Beitrag zur Experimentellen Untersuchung von Gleichstrommaschinen). E. Arnold. Paper before the Verband Deutscher Elektrotechniker, giving an account, with diagrams and tables, of experiments and tests with direct-current dynamos at the Karlsruhe Technical High School. 7000 w. Elektrotech Zeitschr—June 18, 1903. No. 56246 B.

Discussion.

Central Station Development. Discussion of papers dealing with different combinations in the system of distribution, by H. A. Lardner, Philip Torchio, and Peter Junkersfeld. 22000 w. Trans Am Inst of Elec Engrs—May, 1903. No. 56354 D.

Dresden.

See Mechanical Engineering, Steam Engineering.

Factory Plant.

Electrical and Steam Equipment of a Hardware Factory. W. G. Viall. An illustrated description of a lighting and power plant in New Britain, Conn. 1200 w. Am Elect'n—July, 1903. No. 56633.

Frictional Losses.

The Separation of the Frictional Losses in Electric Machines (Die Trennung der Reibungsverluste bei Elektrischen Maschinen). Dr. Leo Finzi. A description of methods for determining the air friction and the bearings friction of dynamos and motors. Diagrams. 800 w. Elektrotech Zeitschr—July 9, 1903. No. 56-258 B.

Heyland Generator.

On Induction Machines and a New Type of Polyphase Generator. A. C. Eborall. An account of a new type of polyphase generator designed by Alexander Heyland, with remarks on its development. 2700 w. Elect'n, Lond—July 3, 1903. Serial. 1st Part. No. 56569 A.

Hydro-Electric.

The Hydro-Electric Plants of Vouvry and Sault Ste. Marie (Die Elektrizitätswerke Vouvry und Sault Ste. Marie). Kurt Meyer. An illustrated description of a plant operating under a 950-meter head near the Lake of Geneva, Switzerland, and of the Sault Ste. Marie plant in Michigan. 6000 w. Zeitschr d Ver Deutscher Ing—June 27, 1903. No. 56234 D.

Electric Power from the Hudson. Alton D. Adams. Illustrates and describes this important development at Spier Falls, which will supply electric light, power and traction in Albany, Troy, Schenectady, and many other places. 1600 w. Elec Wld & Engr—June 27, 1903. No. 56445.

The Spier Falls Dam and Power Plant of the Hudson River Water Power Company. George E. Howe. A full description, with illustrations, of this great engineering work and its construction. Power will be furnished to Albany, Troy and other cities and towns. 4800 w. Eng Rec—June 27, 1903. No. 56448.

Hydraulic Developments as Related to Electric Installations. William B. Jackson. On the necessity of considering the actual conditions of flow before deciding upon the development, with illustrated description of methods. General discussion. 11000 w. Jour W Soc of Engrs—June, 1903. No. 56399 D.

Losses.

Loss by Electric Lighting Companies Through Poor Meters and Transformers. Information furnished by the Westing-

house Company in regard to a case where great loss was detected due to these causes. 1200 w. Eng News—June 25, 1903. No. 56359.

Manchester, Eng.

The New Electricity Works of the Manchester Corporation. An illustrated detailed description of the largest electric power distribution undertaking in Great Britain. 4000 w. Elec Rev, Lond—June 26, 1903. Serial. 1st Part. No. 56480 A.

Niagara Falls.

Electricity at Niagara Falls. An illustrated description of power house No. 2, and its equipment. 2500 w. Engr, Lond—June 26, 1903. No. 56496 A.

Olean, N. Y.

Power Stations of the Olean, N. Y., Street Ry. Brief illustrated description of the Olean and the new Ceres generating plants, using natural gas as fuel. 1000 w. Steam Engng—July 10, 1903. No. 56-616.

Operation.

Electrical Operation in Central Stations. Howard W. Leitch. Describes the method of operating a station designed on the three-phase system. 3000 w. Power—July, 1903. No. 56409 C.

Parallel Operation.

The Parallel Operation of Alternating-Current Machines (Ueber den Parallelbetrieb der Wechselstrommaschinen). H. Görges. A paper before the Verband Deutscher Elektrotechniker, giving a general discussion of the operation of alternating current generators in parallel. Illustrations. 4000 w. Elektrotech Zeitschr—July 16, 1903. No. 56259 B.

Poplar Works.

Poplar Electricity Works. An illustrated detailed description of these works, with map of the district. 6800 w. Elec Engr, Lond—June 19, 1903. No. 56334 A.

Railway Power Stations.

Central Stations of Electric Tramway Systems. Charles Thonet. A discussion and technical information regarding the maintenance, consumption and efficiency of the different parts of a generating station installation; the cost of the electrical energy measured at the switchboard when using steam, power gas, and hydraulic power. 7000 w. Bul Internat Ry Cong—June, 1903. No. 56401 E.

Tramway Power-House Equipment. E. Kilburn Scott. A series of notes and specifications on electric tramway power equipment. 4800 w. Tram & Ry Wld—July 9, 1903. Serial. 1st Part. No. 56691 B.

The Boston & Worcester Street Railway Power Plant. H. D. Jackson. An illustrated description of the plant in South Framingham, Mass., which represents the latest developments in steam and electrical progress. 1400 w. Engr, U S A—July 1, 1903. No. 56546 C.

Rand.

The Rand Central Electric Works. Brief illustrated description of the largest central power station now at work in the British South Africa colonies. 2200 w. Elec Rev, Lond—July 10, 1903. No. 56-715 A.

Rates.

The Question of Charges for Electric Current (Zur Tariffrage der Elektricitätswerke). Max Schwabach. A discussion of the cost of supplying current from electric stations and the proper system of fixing tariffs. Diagrams, 1600 w. June 25, 1903. No. 56249 B.

St. Louis Fair.

The Temporary Power Station at the World's Fair, St. Louis, Mo. An illustrated description of the machines installed in a temporary station, in order to furnish electrical energy for the dedication ceremonies. 2300 w. Elec Engr, Lond—July 10, 1903. No. 56713 A.

LIGHTING.

Arc Lamps.

Some Notes on Alternating and Direct Current Arcs. P. C. Butte. Read at Con. of Pacific Coast Elec. Trans. Assn. Discusses the action, the relative illumination, the character of illumination, favoring alternating-current enclosed arc, especially for interior illumination. 1700 w. Jour of Elec—July, 1903. No. 56-612 C.

Blue-Printing.

Electric Blue-Print Making. George J. Jones. An illustrated description of the blue-print making machine, in which the electric light is used. 700 w. Sci Am—July 18, 1903. No. 56677.

Mercury Vapor.

The Mercury Vapor Lamp (Die Quecksilber-Dampflampe). Arthur Libesny. An illustrated paper, giving a historical review and description of mercury vapor electric lamps, including the Cooper-Hewitt. Serial. Part 1. 2000 w. Zeitschr f Elektrotech—July 19, 1903. No. 56265 D.

New Forms.

Some Undeveloped Possibilities in the Electric Lighting Field. J. Wright. On new forms of arc and incandescent lamps considered in relation to their possible future development. 2800 w. Page's Mag—July, 1903. No. 56596 B.

Train Lighting.

Electric Lighting of Corridor Trains on the Prussian State Railways. Mr. Wich-

ert, at a meeting of the German Inst. of Mech. Engrs. on April 22, 1903. Translated from *Glaser's Annalen*. The system chosen was that with engine and dynamos fixed on the locomotive and a battery fitted to each carriage. Ill. 8500 w. Bul Internat Ry Cong—June, 1903. No. 56400 E.

MEASUREMENT.

Compass Indicator.

The Indication of Compass Positions at a Distance (Fernübertragung von Kompassstellungen). A description of a method, based on the Wheatstone bridge principle, of indicating the position of a ship's compass at any distance. Diagrams. 700 w. Elektrotech Rundschau—July 1, 1903. No. 56204 D.

Conductivity.

The Electrical Conductivity of Copper. Rollo Appleyard. A study of Matthiessen's standard 100 per cent. conductivity copper, the errors due to density, the resistance of the foot grain, etc., aiming at the attainment of a precise quantity. 2200 w. Elec Rev, Lond—June 19, 1903. Serial. 1st Part. No. 56337 A.

Dynamo-Regulation.

Dynamo-Regulation Testing. F. C. Caldwell. Describes how to make a regulation test. Ill. 2000 w. Engr, U S A—July 1, 1903. No. 56548 C.

Hot-Wire Meter.

Hot-Wire Wattmeter (Hitzdraht-Wattmeter). R. Bauch. A paper before the Verband Deutscher Elektrotechniker, discussing the theory of the hot-wire wattmeter and giving an account of experimental work. Diagrams. 4000 w. Elektrotech Zeitschr—July 9, 1903. No. 56257 B.

Inductance.

Self-Induction Standards and Measurements (Ueber Selbstinduktionsnormale und die Messung von Selbstinduktionen). Dr. E. Orlich. A paper before the Elektrotechnischer Verein, giving an illustrated description of the methods used at the Reichsanstalt, Charlottenburg, for measuring inductances. 4500 w. Elektrotech Zeitschr—June 25, 1903. No. 56251 B.

Induction Meters.

Improvements in Electric Meters Constructed on Ferraris's Principle (Neuerungen an Motorelektricitätszählern nach Ferraris-Princip). J. Busch. A paper before the Verband Deutscher Elektrotechniker, giving an illustrated description of induction-motor watt-hour and other electric meters. 1400 w. Elektrotech Zeitschr—July 2, 1903. No. 56252 B.

Motor Testing.

Brake Horse Power and Efficiency of a Small Motor. J. L. Dickson. A description of a method of measurement used for various loads. 300 w. Elec Wld & Engr—July 18, 1903. No. 56739.

Pyrometer.

An Optical Thermo-Electric Pyrometer (Lunette Pyrométrique à Réticule Thermo-Electrique). Ch. Féry. An illustrated description of a pyrometer, consisting of a telescope containing a thermo-electric couple, which is directed toward the hot body or to an opening in the furnace whose temperature is to be measured. 1500 w. Génie Civil—May 30, 1903. No. 56906 D.

Three-Phase.

A Note on Three-Phase Power Measurement. F. A. Fish. Describes a method used by the writer based on the principle of increasing the angle between the current in the pressure coil and that in the series coil of the watt meter. 1200 w. Elec Wld & Engr—June 27, 1903. No. 56446.

Water Gauge.

An Electric Water Gauge (Ueber Elektrische Wasserstandsfernmelder). Karl Busse. An illustrated description of an electric apparatus for recording, at any distance, the level of water in a reservoir, tank, etc. 800 w. Elektrizität—May 2, 1903. No. 56201 C.

POWER APPLICATIONS.

Caspian Oil Wells.

See Electrical Engineering, Generating Stations.

Crane.

A Four-Ton Electric Crane (Elektrisch Betriebener Portalkran von 4,000 kg. Tragkraft). H. Koll. An illustrated description of a jib crane carried on a traveling bridge running on tracks, used for loading and unloading in Mannheim harbor, on the Rhine. 1200 w. Zeitschr d Ver Deutscher Ing—June 20, 1903. No. 56232 D.

Electric Crane Experiences. A. D. Williams. Discusses the care and operation, repairs, accidents, etc. 1300 w. Am Mach—July 23, 1903. No. 56777.

Dock Equipments.

The Modern Equipment of Docks, with Special Reference to Hydraulic and Electric Appliances. Walter Pitt. Read before the Engng. Con. of the Inst. of Civ. Engrs. Also abstract of discussion. Advocates the substitution of electric for hydraulic power transmission and compares the relative costs. 2000 w. Elect'n, Lond—July 3, 1903. No. 56571 A.

Electric Driving.

Electric Driving (Applications de l'Electricité à la Distribution de la Force Motrice dans les Ateliers et les Diverses Exploitations Industrielles). E. de Mar-

chena. A general review of electric driving in factories and shops and discussion of different systems. 16000 w. Mem Soc Ing Civils de France—May, 1903. No. 56-936 G.

Electrically Driven Turret Lathe. Illustrated description of an arrangement that enables a motor having a moderate speed variation to be attached direct to the lathe by gearing, and without the intervention of a cone pulley or similar speed-changing device. 1100 w. Engr, Lond—July 3, 1903. No. 56586 A.

Motor-Driven Machine Tools. An illustrated article showing the latest practice in applying individual drives to shapers. 1500 w. Am Engr & R R Jour—July, 1903. No. 56627 C.

Some Experiences with Electrically Driven Printing Machinery. An account of difficulties arising in electrically-driven printing works in London, and the cause and remedy. 1800 w. Elec Engr, Lond—June 26, 1903. No. 56477 A.

Furnace Charging.

See Mining and Metallurgy, Iron and Steel.

Heyland Motor.

The Heyland Induction Motor. A. S. M'Allister. A study of this invention explaining how the provision of an exciting current in the rotor winding takes the place of the usual primary exciting current. Ill. 3000 w. Am Elect'n—July, 1903. No. 56634.

Mines.

Electric Power Appliances in the Mines of Europe. Emile Guarini. An extensively illustrated review of current practive on the Continent. The first part deals with surface plant, generating stations, lighting, and signaling. Serial. 3500 w. The Engineering Magazine—Aug., 1903. No. 56299 B.

Continuous and Alternatng Currents Applied to Mining. Ellis H. Cropper. Lecture delivered before the Nat. Assn. of Colliery Mgrs. Deals with electricity applied to mining, considering the two systems of electrical transmission and distribution of power. 4400 w. Ir & Coal Trds Rev—July 17, 1903. No. 56823 A.

Pumping.

Electrical Equipment of the New Orleans Drainage System. William Mayo Venable. Illustrated description of pumping stations driven by electric power. A very large equipment of three-phase machinery. 1200 w. Elec Rev, N. Y.—July 4, 1903. No. 56522.

Railway Motors.

Railway Motors with Compound Winding (Bahnmotoren mit Kompoundwickelung). H. M. Hobart. An illustrated account of tests made on Johnson-Lundell electric railway motors with compound winding and two commutators. 1 Plate. 1500 w. Zeitschr f Elektrotech—June 28, 1903. No. 56263 D.

See also Street and Electric Railways.

Repulsion Motor.

The Repulsion Motor. Notes from an article by M. Marius Latour, recently published in the *Elektrotechnische Zeitschrift*. Gives a diagrammatic sketch of repulsion motor with distributed stator windings, explaining the theory. 1300 w. Elect'n, Lond—July 10, 1903. No. 56718 A.

A New Single-Phase Motor (Nouveau Matériel à Courant Alternatif Simple). Marius Latour and M. Gratzmuller. The theory of a new single-phase alternating current motor for railway work, and illustrated description of one and results of tests. 3000 w. Bull Soc Internat d Electriciens—June, 1903. No. 56938 H.

Rolling Mills.

The Electric Driving of Reversing Trains of Rolls (Der Elektrische Antrieb von Reversier-Walzenstrassen). Carl Ilgner. An illustrated discussion of electric driving for rolling mills, and account of experiments with an electric mine hoist. 1400 w. Stahl u Eisen—July 1, 1903. No. 56278 D.

Silk Weaving.

Silk Weaving at St. Etienne. Daniel Bellet. An account of the latest improvements by the addition of electric motors for driving the looms in the homes. Ill. 3000 w. Trac & Trans—June, 1903. No. 56305 E.

Single-Phase Motors.

A New Single-Phase Motor (Ein Neuer Einphasenmotor). L. Schüler. An illustrated description of a single-phase alternating-current motor working on the rotary-field and the repulsion principle, with a commutator. 2500 w. Elektrotech Zeitschr—July 16, 1903. No. 56260 B.

Single-Phase Motors on Multi-Phase Plants. H. A. Bullard. Read at Con. of Pacific Coast Elec. Trans. Assn. Explaining its value in polyphase plants, and describing the Wagner single-phase motor and its operation. 1800 w. Jour of Elec—July, 1903. No. 56610 C.

Single-Phase Motors as a Means of Increasing Station Earnings. An explanation of the ways the single-phase alternating current motor tends to the development of economic production. 2000 w. Can Engr—July, 1903. Serial. 1st Part. No. 56508.

Speed Control.

Relative Advantages of Electrical and Mechanical Methods of Variable Speed Control for General Power Service. Wil-

liam Cooper. Read at Convention of Nat. Elec. Lgt. Assn. Discusses the advantages and disadvantages of both systems. 5500 w. Am Elect'n—July, 1903. No. 56635.

Turntable.

New Electric Turntable in Germany. Illustrations showing an electric turntable of interest, with brief notes. 200 w. U S Cons Repts, No. 1706—July 25, 1903 No. 56802 D.

Variable-Speed Motors.

A Direct-Current Electric Motor Whose Speed Can Be Widely Varied (Gleichstrom-Elektromotoren mit in Weiten Grenzen Veränderlichen Tourenzahlen). F. Müller. An illustrated description of a motor with auxiliary winding on the armature creating a counter e. m. f. This winding is in sections which can be cut in and out. 1000 w. Elektrotech Rundschau—April 1, 1903. No. 56203 D.

Variable-Speed Motors and Their Relation to New Shop Methods. Robert T. E. Lozier. Considers the steps which have made for progress in the application of electric motors to machine driving, and the effect of individually applied motors on efficiency and output of shops. 3000 w. Can Engr—July, 1903. No. 56505.

TRANSMISSION.

Composite System.

Composite System of Electrical Transmission and Distribution. Frederick Bedell. Read before the Cleveland Electric Club. Shows some of the ways this system is used for transmission and distribution, pointing out its advantages. 1600 w. Elec Wld & Engr—July 4, 1903. No. 56541.

India.

Electric Power and Transmission in India. An interesting account of the large transmission plant recently completed in Mysore, and used for working the Kolar gold mines, 92 miles distant. Refers to some peculiar problems due to the region. 1800 w. U S Cons Repts, No. 1703—July 22, 1903. No. 56733 D.

Electrical Conditions in India. Arthur C. Hobble. States present conditions, explaining why electrical engineering projects have not kept pace with other engineering enterprises, and gives a brief account of the "Cauvery Power Scheme," which furnishes power for the Kolar gold fields. 1200 w. Elec Rev, N. Y.—July 25, 1903. No. 56834.

Long Distance.

Electric Railway Service as Supplied by Long Distance Power Transmission. Allen H. Babcock. Read at Con. of the Pacific Coast Elec. Trans. Assn. A brief review of the present situation and future outlook, especially on the Pacific Coast. 1800 w. Jour of Elec—July, 1903. No. 56613 C.

The Arrangement and Control of Long-Distance Transmission Lines. E. W. Cowan and L. Andrews. Abstract of paper read before the Manchester Soc. of the Inst. of Elec. Engrs. A discussion of the systems used and present practice. 3800 w. Elect'n, Lond—July 10, 1903. Serial. 1st Part. No. 56719 A.

Pacific Coast.

A Coming Problem for the Pacific Coast Engineer. W. F. Lamme. Read at Con. of Pacific Coast Elec. Trans. Assn. States the advantages of 3,000 alternations instead of 7,200, and the problem is how to change from high to low. 700 w. Jour of Elec—July, 1903. No. 56611 C.

Three-Phase.

A Three-Phase Power Transmission Plant Using High-Tension Motors. Frank C. Perkins. Illustrates and describes an interesting plant in Germany built by the Oerlikon Works. 1600 w. Elec Rev, N. Y.—July 25, 1903. No. 56836.

Transformers.

High-Tension Transformers. J. W. Farley. Describes the transformers of the Shawinigan Water & Power Co. as typical of the latest and best engineering practice in the design of high tension apparatus. 2600 w. Can Engr—July, 1903. Serial. 1st Part. No. 56507.

Vancouver.

Electrical Transmission at Vancouver. An illustrated article describing the hydro-electric transmission plant of the Vancouver Power Co., which will be capable ultimately of delivering 30,000 horsepower. 2400 w. B C Min Rec—July, 1903. No. 56606 B.

MISCELLANY.

Agriculture.

Electricity in the Service of Agriculture (Die Elektrizität im Dienste der Landwirtschaft). Hr. Budérus. An address before the Landwirtschaftlicher Verein at Frankfurt-on-the-Oder, giving a general review of the applications of electricity to agriculture. Serial. 2 Parts. 3000 w. Elektrotech Rundschau—July 1 and 15, 1903. No. 56205 each D.

Balata.

Notes on Balata. H. L. Terry. Remarks on its origin, collection, and employment. 1700 w. Elect'n, Lond—July 10, 1903. No. 56717 A.

Education.

Electrical Engineering Instruction at Columbia University. George F. Sever. Reviews the work in electricity at this university, and gives a chart showing the technical entrance requirements, the

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course of four years' study, etc. 1600 w. Elec Wld & Engr—June 27, 1903. No. 56447.

The Training of the High Tension Engineer. P. M. Lincoln. Read at the convention of the Can. Elec. Assn. On the relations which should exist between the colleges and outside work. Also discussion. 5800 w. Can Elec News—July, 1903. No. 56801.

Electrical Inspector's Report.

Report of the Electrical Inspector of Factories and Workshops. G. S. Ram. The first report to the Home Office, suggesting improvements tending to safety in working, and calling attention to the variety of methods in use and absence of standard practice. 5500 w. Elect'n, Lond—July 3, 1903. No. 56572 A.

Electric Shocks.

Electric Shocks. Archibald Wilson. Showing that the conditions are extremely improbable under which accidental contact with electric wires can result in dangerous shock. 3500 w. Cassier's Mag—July, 1903. No. 56602 B.

Firestream Conductivity.

The Danger to Firemen When Directing a Stream of Water on Live Wires (Was Ist Ueber die Gefährdung der Feuerwehr beim Anspritzen Stromdurchflossener Drähte zu Sagen). Friedr. Heinicke. An account of experiments which determined the electromotive force between earth and the nozzle of a hose from which a stream of water played on wires carrying high and low tension polyphase and direct currents. Tables. 1500 w. Elektrotech Zeitschr—June 18, 1903. No. 56247 B.

Igniter.

A New Magneto-Electric Igniter (Neuer Magnetelektrischer Zündapparat mit Uebersprin genden Funken). An illustrated description of an igniting apparatus for internal-combustion engines, in which a magneto is wound so as to give a particularly good spark. 1200 w. Elektrizität—May 2, 1903. No. 56202 C.

The Goodson Igniter. Hugh Dolnar. States the advantages of electric ignition, describes the two present methods of producing the spark, and gives illustrated description of the invention named. 2000 w. Autocar—June 27, 1903. No. 56470 A.

Lightning.

Necessary Practical Safeguards Against Fires Caused by Lightning. Alfred Hands. Abstract of a paper read before the Fire Prevention Congress, England. Explains the force of lightning and discusses points necessary to protect buildings. 2200 w. Elect'n, Lond—July 17, 1903. No. 56807 A.

Shipboard.

Uses of Electricity on Board Ship. J. W. Kellogg. Reviews this development since 1880, when the first plant was put into operation, describing modern plants. The present series of articles considers only the uses for lighting and power. Ill. 3700 w. Marine Engng—July, 1903. Serial. 1st Part. No. 56424 C.

United States.

A Traveler's Impressions of the United States (Reiseeindrücke aus den Vereinigten Staaten). Dr. F. Niethammer. A paper before the Elektrotechnischer Verein of Vienna, giving an illustrated general account of electrical engineering in America. Serial. 3 Parts. 10000 w. Zeitschr f Elektrotech—July 5, 12 and 19, 1903. No. 56264 each D.

Welding.

Improvements in Electric Track Welding. George E. Walsh. Describes the process of welding under the present system. 1500 w. Elec Rev, N. Y.—July 25, 1903. No. 56835.

GAS WORKS ENGINEERING

Acetylene.

Acetylene Stored and Transported in Safety. John S. Seymour. Describes a system for the safe transportation and storage of acetylene in tanks of special equipment, explaining the principle, and giving information of interest. 6500 w. Jour Fr Inst—July, 1903. No. 56391 D.

Town Lighting by Acetylene. Augustine Davis. Considers it more economical and of better quality than by gas or electricity. 1500 w. Munic Jour & Engr—July, 1903. No. 56435 C.

Bury, Eng.

From Siding to Coke-Store at the Bury Gas-Works. An inquiry into the cost of labor with machine-worked horizontal retorts. Ill. 2800 w. Jour Gas Lgt—June 30, 1903. No. 56563 A.

Carbonizing.

The Settle-Padfield Carbonizing Process. Illustrates and describes a bench of these vertical retorts under construction at Exeter, giving particulars of the apparatus and the special features of the invention. Reports test. 3000 w. Jour Gas Lgt—June 23, 1903. No. 56402 A.

Coke-Handling.

Coke-Handling in French Gas Works. Illustrates and describes the very complete

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plant installed by the Compagnie Parisienne d'Eclairage and de Chauffage par le Gaz, which includes a number of electrically driven machines for breaking, screening and drying the coke. 2000 w. Engng—July 17, 1903. No. 56819 A.

Cost of Gas.

Cost of Municipal vs. Private Gas. Alton D. Adams. Claims that the methods of operating private gas plants are expensive and that municipal plants are run more economically, and can therefore furnish cheaper gas. 1500 w. Munic Jour & Engr—July, 1903. No. 56434 C.

Gas Producers.

Some Recent Forms of Gas Producer. Prof. A. H. Sexton. Illustrates and describes some forms of producer suitable for the production of ordinary producer gas. 1800 w. Prac Engr—July 3, 1903. No. 56565 A.

Gas Testing.

Gas and Gas Testing. H. Leicester Greville. A brief comparison of new with old methods of testing, with comments on recent papers and discussions, and suggestions. 2000 w. Jour Gas Lgt—July 14, 1903. No. 56786 A.

Incandescent Lighting.

New Apparatus for Incandescent Gas Lighting (Les Nouveaux Appareils d'Eclairage au Gaz par Incandescence). H. Guérin. Illustrated descriptions of various high pressure and medium pressure lamps. 2500 w. Génie Civil—June 27, 1903. No. 56916 D.

Intensified Lighting.

High-Pressure Gas Lighting in Lace Factories. Report of W. J. A. Butterfield of investigations made of the hygienic aspect of the question. Ill. 3300 w. Jour Gas Lgt—June 23, 1903. No. 56403 A.

Mantles.

Lighting Power with Incandescent Mantles. M. Sainte-Claire Deville, before the International Photometry Com. at Zurich. Describes the method used at the Paris gas-works for finding the highest maximum illuminating power per unit of volume used per hour, and suggests a method relying upon heating values. 1500 w. Gas Wld—July 11, 1903. No. 56712 A.

Photometry.

Photometry Up to Date. A discussion of means of ascertaining the illuminating power as applied to English methods and gas undertakings. 2200 w. Jour Gas Lgt —July 14, 1903. No. 56785 A.

I. An Improved Photometer for Testing the Illuminating Values of Ordinary and High-Power Welsbach Burners. Charles Carpenter and J. W. Helps. II. Photometry of Incandescent Burners. U. Della Cassa and M. Böhm. Two short papers describing methods. 1500 w. Gas Wld—July 4, 1903. No. 56562 A.

Power Gas.

Commercial Gases for Power Purposes. Alexander M. Gow. General information concerning the use of gas in gas engines. The constituents of commercial gases, the utilization of blast furnace gases, etc., are discussed. 10000 w. Pro Engrs Soc of W Penn—May, 1903. No. 56856 D.

Retorts.

Construction and Working of Modern Retort Settings. The first of a series of articles aiming to assist those whose opportunities have been limited. They will consider the theoretical side of the question and the practical adaptations of the principles. Ill. 1100 w. Gas Wld—June 27, 1903. Serial. 1st Part. No. 56471 A.

A Comparison Between the First Cost of Inclined and Horizontal Retorts. M. Frère. Read before the Société Technique du Gaz at Toulon. 1500 w. Jour Gas Lgt—July 14, 1903. No. 56789 A.

An American Arrangement of Vertical Retort. Illustrations and portion of patent specifications of an invention by Charles F. Dieterich, issued about twenty years ago, and having features similar to the Bueb system. 1500 w. Jour Gas Lgt —July 14, 1903. No. 56787 A.

Shrewsbury, Eng.

The Old and the New at Shrewsbury. An illustrated article describing extensive alterations and enlargements. 6300 w. Jour Gas Lgt—July 7, 1903. No. 56687 A.

Sulphur Recovery.

The Claus Sulphur-Recovery Process at Granton. From the report of Mr. R. Forbes Carpenter, in regard to experiments made, giving results and conclusions. 1800 w. Jour Gas Lgt—June 30, 1903. No. 56564 A.

United Kingdom.

Something About Gas Works in the United Kingdom. Frederic Egner. Information in regard to the gas undertakings of England, Scotland, and Ireland abstracted from parliamentary papers. 1500 w. Am Gas Lgt Jour—July 27, 1903. Serial. 1st Part. No. 56829.

Wood Gas.

Motive Power from Wood (Les Forces Motrices dans les Régions sans Eau et sans Charbon, et en Particulier aux Colonies). A. Lombard. An illustrated description of the Riché wood distillation process, and of the use of wood gas in engines, with views of several plants in French colonies and other parts of the world. 3000 w. Rev Technique—May 25, 1903. No. 56921 D.

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INDUSTRIAL ECONOMY

Apprenticeship.

Apprenticeship in Engineering Training. John Dewar Cormack. Read before the Engng. Con. of the Inst. of Civ. Engrs. The discussion is confined to the training of youths destined for responsible positions, as employers, manufacturers, consulting engineers, etc. Also general discussion. 8000 w. Engng—June 26, 1903. No. 56487 A.

The Apprenticeship System at Brown & Sharpe's. William A. Viall. Read at meeting of Nat. Mach. Tool Bldrs. Assn. Explains the system in the shop named, with general remarks. 1800 w. Ir Age —July 2, 1903. No. 56422.

British Trade.

British Trade and the Central European Railways. A study of the influence of the various railway tunnels in Europe upon commerce. Map. 5700 w. Trac & Trans—July, 1903. No. 56722 E.

Imperial Policy and Free Trade. Three articles, by Sir Robert Giffen, Edward Dicey, and Benjamin Kidd, discussing this subject and Mr. Chamberlain's policy. 25900 w. Nineteenth Cent—July, 1903. No. 56668 D.

Imperial Trade and Tariffs. Benjamin Taylor. A discussion of Mr. Chamberlain's views on imperial reciprocity. 4400 w. Page's Mag—July, 1903. No. 56-597 B.

China.

Notes on China (Notes sur la Chine). F. Sibel. An illustrated account of navigation on the Yang-tse-Kiang, and of building and other industries in China. Serial. 3 Parts. 5500 w. Rev Technique—May 25, June 10 and 25, 1903. No. 56923 each D.

Consulting Engineers.

The Consulting Engineer. Dr. Alexander B. W. Kennedy. An inaugural address at the City and Guilds Cent. Tech. College. On the duties and work of the engineer. 5500 w. Arch't, Lond—July 10, 1903. No. 56672 A.

Cyanide.

The Position of the Cyanide Industry. George E. Beilby. Read at Berlin meeting of the International Cong. of Applied Chemistry. Gives the leading events in the history of this industry, both as relating to consumption and production. 3800 w. Jour Gas Lgt—July 7, 1903. No. 56688 A.

Dalny.

The Building of Dalny. Information of interest concerning this Manchurian commercial seaport, its population, industries, railway and steamship service, etc. 3000 w. U S Cons Repts, No. 1708—July 28, 1903. No. 56825 D.

Education.

The Reform in Mathematical Education. An account of the present position of the new method of teaching mathematics to young engineers in England. 3700 w. Engng—June 19, 1903. No. 56309 A.

Industrial Schools in Germany. A report on technical education in Germany. 2500 w. U S Cons Repts, No. 1704—July 23, 1903. No. 56757 D.

Engineering Problems.

Some Unsolved Problems in Engineering. W. H. Maw. "James Forrest" lecture before the Inst. of Civ. Engrs. Considers the economical generation and distribution of power, steam engines, internal combusiton engines, etc.; constructional engineering and the materials employed; cutting tools, etc. 11000 w. Engng—June 26, 1903. No. 56490 A.

The James Forrest Lecture. W. H. Maw. A review of this lecture, with extracts. Deals with heat engines, fatigue of metals and other problems. 2500 w. Engr, Lond—June 19, 1903. No. 56327 A.

Factories.

The Decentralization of Factories. T. C. Elder and Herbert J. Scoble. Gives a presentation of existing conditions and discusses the "Garden City" scheme proposed by Mr. Ebenezer Howard, and the "Industrial Redistribution" pamphlet, by W. L. Magden, with special reference to England. 6700 w. Trac & Trans—June, 1903. Serial. 1st Part. No. 56302 E.

India.

The Industrial Regeneration of India. John Wallace. A statement of present industrial conditions, the methods of manufacture, machinery used, habits of the people. etc., discussing the question of technical education. 6500 w. Cassier's Mag—July, 1903. No. 56600 B.

Industrial Efficiency.

The Promotion of Industrial Efficiency and National Prosperity. III. The Future, and Trades-Union Hostility. John B. C. Kershaw. Discusses the attitude of organised labour toward the newer wage systems and answers the objections the trades union leaders make to the present industrial philosophy as held by employers. Serial. 3rd Part. 2500 w. The Engineering Magazine—Aug., 1903. No. 56908 B.

Labour.

Capital and Labour Harmony. Andrew Carnegie. Reprint of a portion of the

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presidential address before the Iron and Steel Inst. Deals with the methods adopted by the Carnegie Steel Company, and of the United States Steel Corporation, in which partnership and profit-sharing were carried to a far-reaching extent. 7000 w. Cassier's Mag—July, 1903. No. 56598 B.

The Anti-Boycott Movement. Daniel Davenport. Read before the Central Supply Assn. Describes the purpose of the Anti-Boycott Association. 1200 w. Ir Age—July 16, 1903. No. 56682.

Manufactures.

The Census of Manufactures of 1900. Charles E. Monroe. Reviews the history of census taking in the United States, especially discussing the methods of obtaining statistics in regard to manufactories, the defects of the system, and the effects. 7000 w. Jour Fr Inst—July, 1903. Serial. 1st Part. No. 56392 D.

Municipal Trading.

Municipal Trading and Local Rates. Robert Donald. A criticism of an article in the April number, by Hon. Robert P. Porter. 4000 w. Trac & Trans—June, 1903. No. 56300 E.

Osaka Exhibition.

The Osaka Exhibition, Japan. Editorial review of the exhibits and of the portents which they suggest. Chiefly devoted to the machinery section. 2700 w. Engng—July 10, 1903. No. 56706 A.

Philippines.

Military Engineering and Civil Opportunities in the Philippines. Captain William W. Harts. An illustrated account of what has been done by the army of occupation, with some interesting particulars of methods, and an estimate of the work to be accomplished by civil engineers under the civil administration of the islands. 1300 w. Illustrated. The Engineering Magazine—Aug., 1903. No. 56901 B.

The Labor Question in the Philippines. Edwin Maxey. A discussion of the industrial education of the native Filipino. 2000 w. Gunton's Mag—July, 1903. No. 56390.

Piece-Work.

A Remodeled Piece-Work System. John H. Van Yorx, Jr. A practical working description of a plan designed to give a maximum of the necessary detailed information with a minimum of clerical work by any of the shop employees. Illustrated with fac-similes of all the forms used. 4000 w. The Engineering Magazine—Aug., 1903. No. 56902 B.

South Africa.

South African Business. F. J. Frank. Considers some of the mistakes which have been made and which should be avoided, and the opportunities for manufacturers. 2500 w. Mines & Min—July, 1903. No. 56539 C.

Workmen's Insurance.

Workmen's Insurance in Germany (Die Deutsche Arbeiter-Versicherung). Fr. Pichler. Paper before the Technischer Verein of Baltimore, giving an account of the system of workmen's insurance instituted by the German government, in which both employer and employee contribute to the fund. Diagrams. 3000 w. Technologist—July, 1903. No. 56196.

MARINE AND NAVAL ENGINEERING

American Shipbuilders.

Suggestions to American Shipbuilders. Remarks on the lack of system in specifications accepted by builders, and the advantage of standard specifications. 1400 w. Marine Engng—July, 1903. No. 56430 C.

Armor.

The Theory and Practice of Armor-Attack. Describes the effect produced by capped and uncapped shot. 1500 w. Engr, Lond—July 17, 1903. No. 56810 A.

Auxiliary Machinery.

The Auxiliary Machinery of Steam Vessels. Jasper E. Cooper. Two articles dealing with this subject. The present considers turning and reversing engines, air and circulating pumps, condensers, feed pumps, and feed heaters. Ill. 6500 w. Cassier's Mag—July, 1903. Serial. 1st Part. No. 56601 B.

Battleships.

The 13,000-Ton Battle Ship Problem. Gives extracts from a letter by Admiral Bradford, protesting against the adoption of the plans submitted by the Board of Construction. Also Admiral Melville's indorsement of the protest. 2200 w. Ir Age—July 30, 1903. No. 56852.

H. M. S. Centurion Reconstructed. Illustration, with description of changes made. 800 w. Engr, Lond—June 19, 1903. No. 56330 A.

Canal-Boat Motors.

The Deutz Boat Motors (Deutzer Bootsmotoren). Julius Küster. Illustrated descriptions of gas generators and engines and their application to canal boats. 1500 w. Zeitschr d Mitteleuropäischen Motorwagen Ver—No. 10, 1903. No. 56227 D.

We supply copies of these articles. See page 958.

Cargo Steamer.

German-Built Cargo Steamer. Illustrated description of the cargo ship "Lichtenfels," showing latest practice. 600 w. Marine Engng—July, 1903. No. 56428 C.

Channel Steamers.

Cross-Channel Steamers. Prof. J. H. Biles. Read before the Inst. of Nav. Archts. Considers the points of difference between channel and ocean-going steamers, giving a summary of the lines and tonnage employed, etc. 2200 w. Engng—July 10, 1903. No. 56708 A.

Clyde.

The Clyde and Naval Work. Begins a detailed account of the warship work in hand, done, and proposed to be done on the Clyde. 1500 w. Engr, Lond—July 17, 1903. Serial. 1st Part. No. 56811 A.

Colliers.

Fast Colliers for the British Navy. E. H. T. d'Eyncourt. Presents arguments showing the need of these vessels, and some suggestions regarding them. Ill. 1800 w. Cassier's Mag—July, 1903. No. 56604 B.

Cruiser Trials.

The War Conditions Trial of the Europa and Spartiate. An account of the performance of these cruisers which, it is claimed, have rehabilitated the Belleville boiler. After a trip of 20,000 miles, under trying conditions, no defect of importance is found. 1500 w. Engr, Lond—July 10, 1903. No. 56695 A.

Electricity.

See Electrical Engineering, Miscellany.

Electric Launches.

German, English and American Electric Launches. Frank C. Perkins. Illustration, with brief descriptions of some of these interesting vessels. 1000 w. Marine Engng—July, 1903. No. 56432 C.

See also Street and Electric Railways.

England.

Progress of Warships and Machinery Building in England. A record of what has been accomplished in ship-yards and engine-works during the past half-year ending June 30th. 2300 w. Engr, Lond—July 3, 1903. No. 56584 A.

Evaporators.

Running Evaporators. Earl N. Percy. Remarks on the operation and care of evaporators, describing various methods. 2500 w. Marine Engng—July, 1903. No. 56427 C.

Express Steamers.

Express Steamers for Short Voyages. Albert Edward Seaton. Read at the Engng. Con. of Inst. of Civ. Engrs. Considers the causes of differences in steamers for different routes between England and various points. 3000 w. Engng—July 3, 1903. No. 56581 A.

Floating Docks.

Development in Floating Dry-Docks. Joseph J. Schultz. Points out their striking advantages over the graving type, especially in economy and range of adaptability, and gives in brief the structural features of all the important forms of floating dock. Illustrated. 4000 w. The Engineering Magazine—Aug., 1903. No. 56900 B.

A 6,000-Ton Floating Depositing Pontoon Dock. An illustrated description of the dock at Barcelona. 1800 w. Sci Am—July 11, 1903. No. 56658.

The Barcelona Depositing Dock. Illustrates and describes a depositing floating dock which is an ingenious combination of pontoons and staging which enables several vessels to be repaired at the same time. 700 w. Marine Engng—July, 1903. No. 56423 C.

Italian Steamships.

New Steamship Umbria and Liguria. Brief illustrated description of the last of five vessels of the Nav. Gen. Italiana Co. placed in American service. 900 w. Marine Engng—July, 1903. No. 56426 C.

"Kaiser Wilhelm II."

The "Kaiser Wilhelm II." Gustav H. Schwab. An illustrated detailed description of the newest and largest Atlantic liner. 2500 w. Cassier's Mag—July, 1903. No. 56599 B.

T. S. S. "Kaiser Wilhelm II." An illustrated article giving a general idea of this largest high-speed liner that has yet been completed. Following articles will enter fully into details. 5500 w. Engng—July 10, 1903. Serial. 1st Part. No. 56702 A.

Launch.

The Coaching Steam Launch "Moguntia" (Trainier-Dampf-Schnellboot "Moguntia). An illustrated description of a launch built for a rowing club by Escher Wyss & Co., of "tetrahedral" shape, about 35 feet long and 14 knots speed, and using oil fuel for boilers. 800 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 5, 1903. No. 56222 D.

Log.

Measurement of the Speed of Ships (Mesure des Vitesses des Navires à la Mer). E. Guyou. Description of a modification of the ship log, the speed of the log line and the revolutions of the main shaft being both electrically registered on a strip of paper. 600 w. Comptes Rendus—May 18, 1903. No. 56945 D.

Mercantile Cruisers.

On Mercantile Cruisers Fitted with

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Housing Propellers. James Hamilton. Read before the Inst. of Nav. Archts. (England). Suggests a means by which it may be possible, when on passenger service, by holding in reserve a part of the total power provided in the ship, to save a large portion of the proposed subsidies, or the portions connected with running the vessels on passenger service. Also discussion. 2800 w. Engng—July 3, 1903. No. 56580 A.

Model Tank.

Experiment Station for Hydraulics and Shipbuilding, in Berlin (Versuchsanstalt für Wasserbau und Schiffbau in Berlin). Hr. Eger. An illustrated description of a basin for experimenting with ship models, and other features of a plant for making experiments in hydraulic and shipbuilding work. 2800 w. Zentralblatt d Bauverwaltung—April 18, 1903. No. 56210 B.

"Okean."

The Russian School Ship and Transport "Okean" (Das Russische Schul- und Transportschiff "Okean"). An illustrated description of a 12,000-ton steamer built at the Howaldt yard in Kiel, Germany, for the Russian government, to be used as a transport between the Baltic and the Pacific and as a school ship for machinists. Serial. 2 Parts. 3 Plates. 1800 w. Zeitschr d Ver Deutscher Ing—June 27, July 4, 1903. No. 56233 each D.

"Prinz Adalbert."

Twin-Screw Steamer "Prinz Adalbert," of the Hamburg-American Line (Doppelschrauben-Passagier- und Frachtpostdampfer der Hamburg-Amerikalinie, "Prinz Adalbert"). Prof. Oswald Flamm. A well-illustrated description of a passenger and express freight steamer of medium size, built at the Bremen Vulcan yard, in Vegesack, Germany, for the Brazil trade. 6 Plates. 3300 w. Serial. 3 Parts. Schiffbau—May 23, June 8 and 23, 1903. No. 56184 each D.

Rivet Holes.

See Mechanical Engineering, Machine Works and Foundries.

Screw-Shafts.

On Screw-Shafts. John List. Read at Engng. Con. of the Inst. of Civ. Engrs. A discussion of present practice and recent improvements, and of points of special interest. 1200 w. Engng—June 26, 1903. No. 56488 A.

Stability.

The Position of Equilibrium of Undamaged and of Leaking Ships (Die Gleichgewichtslage des Unverletzten und des Lecken Schiffes). Ernst Zetzmann. A discussion of the stability of ships under various conditions, and the mathematical treatment of problems in the trim and stability of ships when in normal condition and with one or more compartments filled with water. Diagrams and curves. Serial. 5 Parts. 3500 w. Schiffbau—May 8, 23, June 8, 23, and July 8, 1903. No. 56183 each D.

Steamboats.

The New Inland Passenger and Freight Steamboat Virginia. Illustrated description of a medium size boat operating on Chesapeake Bay. 1500 w. Naut Gaz—July 2, 1903. No. 56504.

New Steamboat "Middlesex," for the Rappahannock River. Illustrates and describes a paddle steamer built for service between Baltimore and Fredericksburg, Va. 1000 w. Marine Engng—July, 1903. No. 56429 C.

Submarines.

Trials of the Submarine Boats Grampus and Pike. Illustrations with report of trial in San Francisco waters. 800 w. Marine Engng—July, 1903. No. 56431 C.

Turbine Steamers.

Channel Steamship "The Queen." An account of the performance of this new turbine-propelled steamer on the Dover-Calais route. 1600 w. Engr, Lond—July 3, 1903. No. 56585 A.

The Steam Turbine and Its Application to the Propulsion of Vessels. C. A. Parsons. Read before the Inst. of Nav. Archts. An interesting review of the work in this field. Ill. 4500 w. Engng—July 10, 1903. Serial. 1st Part. No. 56705 A.

Yachts.

From Cruiser to Racing Machine. A critical review of the cup-defenders, and the design of racing yachts. 2000 w. Sci Am—July 25, 1903. No. 56791.

MECHANICAL ENGINEERING

AUTOMOBILES.

Agriculture.

The Automobile in Agricultural Service (Der Motorwagen im Dienste der Landwirtschaft). Julius Küster. An illustrated description of the employment of automobiles in varous kinds of agricultural work. 2000 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 7, 1903. No. 56224 D.

Ardennes Race.

Circuit des Ardennes. A brief account

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of this race, with illustrations of some of the vehicles, and table giving time record. 1500 w. Auto Jour—June 27, 1903. No. 56468 A.

Berlin Exhibition.

The German Automobile Exhibition at Berlin, 1903 (Deutsche Automobil-Ausstellung, Berlin, 1903). Julius Küster. An illustrated general description of the exhibition and some of the exhibits, including vehicles, motors, and details. Serial. 2 Parts. 7000 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—Nos. 5 and 6, 1903. No. 56221 each D.

The German Automobile Exhibition (Von der Deutschen Automobilausstellung). An illustrated description of various automobiles and their parts shown at Berlin in 1903. Serial. Part 1. 3000 w. Ill. Zeitschr f Klein u Strassenbahnen—April 16, 1903. No. 56188 C.

Buck Board.

The Orient Buck Board. Hugh Dolnar. Brief illustrated description of the novel features of this vehicle exhibited at the Am. Auto. Show. 1200 w. Autocar—July 11, 1903. No. 56710 A.

Congress.

The Automobile Congress at Paris. The first of a series of articles reviewing the proceedings of these meetings and the questions discussed. 3500 w. Engr, Lond—July 3, 1903. Serial. 1st Part. No. 56583 A.

Electric Vehicles.

Applications of Electricity to Driving Carriages in Towns. R. E. B. Crompton. Read before the Engng. Con. of the Inst .of Civ. Engrs. Remarks on the transmission, gear, storage batteries used, and tires. General discussion. 3400 w. Elec Engr, Lond—June 26, 1903. No. 56479 A.

The Contal Electromobile. An illustrated description of a carriage having new features in the running gear and battery. 2500 w. Trac & Trans—June, 1903. No. 56301 E.

See also Street and Electric Railways.

Fender.

See Street and Electric Railways.

Fire Engines.

Chemical Motor Fire Engine. Illustrations and brief description of the Tottenham combined motor chemical fire-engine and fire-escape. 1000 w. Auto Jour—July 4, 1903. No. 56556 A.

Motor Steam Fire-Engines. Illustrations and descriptions of these engines, particularly the one built for Leyland, England. 1100 w. Autocar—July 4, 1903. No. 56558 A.

New Motor Steam Fire Engine for Liverpool. Brief illustrated description. 500 w. Engr, Lond—July 10, 1903. No. 56699 A.

Gasoline Vehicles.

A Discussion of the Gasoline Runabout for the Novice. A. D. River. Considers the general features, giving hints of value. 2500 w. Automobile—June 27, 1903. Serial. 1st Part. No. 56366.

Gordon-Bennett Race.

Narrative of the International Cup Contest. Edward Kenealy. Reports of the race and scenes and incidents on Irish soil, with photographs. 4500 w. Automobile—July 18, 1903. No. 56783.

Previous Contests for Possession of the Gordon Bennett Trophy. A brief review of these annual contests which began in 1900. Ill. 1000 w. Automobile—July 4, 1903. No. 56511.

Results of the Gordon Bennett Race. An account of this race which gave the "cup" to Germany. 1,600 w. Automobile—July 4, 1903. No. 56510.

The Gordon Bennett Automobile Cup Race. An illustrated account of this international motor-car race. 2,800 w. Sci Am—July 25, 1903. No. 56790.

The Gordon Bennett Cup Race. An account of preparations in Ireland, the arrival of the cars, and matters of related interest. Ill. 9,500 w. Motor-Car Jour—July 4, 1903. No. 56557 A.

The Gordon Bennett Cup and Race. An illustrated article giving the history of the cup and of the series of international races which have taken place in connection with it. 2500 w. Autocar—July 6, 1903. (Special No.) No. 56686 A.

The Gordon Bennett Cup Race. An illustrated detailed account of this interesting motor race. 3000 w. Motor Car Jour—July 11, 1903. No. 56709 A.

The Irish Fortnight—The Opening Days and the Gordon-Bennett. An illustrated account of the start, finish and incidents. 15,000 w. Auto Jour—July 11, 1903. No. 56692 A.

Highway Rights.

The Motor and the Birthright of the the Highway. Walter B. Woodgate. Discusses the English common-law positions of motorists and the non-motoring public; the proposed legislation and relative matters. 5,500 w. Nineteenth Cent—July, 1903. No. 56669 D.

The Motor Car and the Public. A protest against the abuses which have sprung up in consequence of the development of the motor car and its use on the public highways. 2,800 w. Trac & Trans—July, 1903. No. 56724 E.

Igniter.

See Electrical Engineering, Miscellany.

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Jenatzky-Martini.

The Jenatzky-Martini Petrol Cars. Begins an illustrated detailed description of the novel features. 2500 w Auto Jour—June 27, 1903. Serial. First part. No. 56469 A.

Krupkar.

The 16 H.-P. "Krupkar" Petrol Vehicle. Illustrated description. 2400 w. Auto Jour—June 20, 1903. No. 56345 A.

Motor Cycles.

Motor Cycles at the German Automobile Exibition (Motor-Zweiräder auf der Deutschen Automobil Ausstellung.) Julius Küster. An illustrated description of various motor cycles exhibited at the Berlin show, in March, 1903. 1600 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 7, 1903. No. 56225 D.

Napier Cars.

The Napier Cars and Works. Illustrates and describes recent cars built by this company and the new works at Acton Vale. 3000 w. Auto Jour—July 4, 1903. Serial. First part. No. 56554 A.

Overland Trip.

Overland Trip from the Pacific Ocean. Marius C. Krarup. An illustrated series of articles giving particulars of trip. The present number describes the crossing of the Sierras by way of Placerville to Slippery Ford. 2000 w. Automobile—July 18, 1902. Serial. First part. No. 56784.

Petrol Cars.

The Use of Petrol Motors for Locomotion. E. Sauvage. Read before the Engng Con. of the Inst. of Civ. Engrs. Notes on the desirable qualities of these engines, and on things to be considered where economy is a consideration. 1500 w. Engng—June 26, 1903. No. 56486 A.

A Simple Petrol Car. Illustrates and describes a design aiming to avoid complicated details liable to cause trouble. 1400 w. Engr, London—July 10, 1903. No. 56701 A.

Railway Cars.

See Railway Engineering, Motive Power.

Railway Feeders.

Autocars and Railways. Norman D. Macdonald. Discussing the effect autocars will have on railways and the writer's opinion, with suggestions as to ways railways may use autocars for traffic gaining. 1600 w. Transport—July 3, 1903. Serial. First part. No. 56561 A.

Speed Recorders.

Recorders for the Protection of Automobilists (Selbstschutz Gegen Unrichtige Polizeiliche Denunziationen Durch Geschwindigkeits-Registratoren). An illustrated description of a speed recorder which marks the maximum speed attained and of the "velograph" which traces a continuous record of the motion of a vehicle. 2500 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 6, 1903. No. 56223 D.

Steam Cars.

Steam Autocar Notes. J. S. V. Bickford. States a preference for water-tube boilers, and gives an account of experiments made both in the shop and on the road. Ill. 3300 w. Engr, Lond—July 17, 1903. No. 56817 A.

The 1903 White Steam Car. Illustrates and describes the interesting features of the present type of these cars. 3000 w. Auto Jour—July 4, 1903. Serial. First part. No. 56555 A.

HYDRAULICS.

Air Lift.

The Raising of Water by Compressed Air. Percy Griffith. Read before the Engng. Con. of the Inst. of Civ. Engrs. A brief summary of the principles governing the operation and of the essential details of construction in its application to the raising of water from wells and borings. 1800 w. Mech Engr—June 27, 1903. No. 56473 A.

Lifting Water by Compressed Air. Gustav C. H. Friedrich. Read before the Ohio Soc. of Mech., Elec. and Steam Engrs. Considers the air-lift pump and the well. 2000 w. Engr, U S A—July 15, 1903. No. 56742 C.

Centrifugal Pumps.

High-Lift Centrifugal Pumps. Cecil West Darley. Read at the Engng. Con. of the Inst. of Civ. Engrs. Describes and gives test of steam turbine-driven centrifugal pumps for high lifts, designed for special conditions in New South Wales. 2400 w. Engng—July 3, 1903. No. 56582 A.

An Improved Centrifugal Dredging Pump. Capt. Mason M. Patrick. An interesting account of trouble experienced in the wear of pumps used in improving the Mississippi River, with illustrations and description of a design aiming to reduce this wear to a minimum. 1700 w. Eng News—July 9, 1903. No. 56650.

Flow.

Approximate Data of Open Streams, Weirs, Pipes, etc. F. S. Beckett. Gives a graphic table of the results and conclusions of formulæ most often required in the line of work indicated, and problems showing the scope and application. 1500 w. Min & Sci Pr—July 18, 1903. No. 56828.

Plumbing.

Hot Water Supply. Illustrated description of two sketches of kitchen boiler and hot-water supply arrangement where one

boiler is above the other. 1500 w. Met Work—July 18, 1903. No. 56654.

Pumping Stations.

See Electrical Engineering, Power Applications.

Turbines.

Progress in Turbine Construction (Fortschritte im Turbinenbau). C. Schmitthenner. A paper giving review of recent progress in turbines and their regulating apparatus, and a particular discussion of Francis turbines, with illustrations and diagrams. Serial. 2 Parts. 5000 w. Zeitschr d Ver Deutscher Ing—June 13 and 20, 1903. No. 56229 each D.

Swiss Turbines of the Girard & Pelton Types. Frank C. Perkins. Illustrates and describes various types used in hydro-electric plants in Europe. 700 w. Min Rept—July 2, 1903. No. 56502.

Water-Wheels.

The Design of Tangential Water Wheels. George J. Henry, Jr. Abstract of a paper read before the Con. of the California Miners' Assn. Discusses the question of governing and the numerous applications of tangential wheels, considering examples taken from actual practice. Ill. 2000 w. Jour of Elec—July, 1903. No. 56615 C.

MACHINE WORKS AND FOUNDRIES.

Apprenticeship.

See Industrial Economy.

Bolts.

The Manufacture of Armour-Plate Bolts. An illustrated description of these bolts and their manufacture. 2000 w. Engng—July 10, 1903. No. 56703 A.

Brass Foundries.

Equipment of Brass Foundries. C. Vickers. Considers the equipment of each shop should be in accordance with the class of work to be done, and offers some suggestions. 1200 w. Am Mach—July 2, 1903. No. 56420.

Castings.

A Small Converter Process for the Manufacture of Steel Castings. Arthur Simonson. A description of the Tropenas process and plant, stating its usefulness and advantages. 2500 w. Foundry—July, 1903. No. 56383.

Castings Finishing.

The Finishing of Castings on Automatic Screw Machines. Gives illustrated description of machines for this work. 1000 w. Engng—July 3, 1903. No. 56579 A.

Clutch Teeth.

The Cutting of Clutch Teeth. Guido H. Marx. An illustrated description of methods of cutting the straight toothed and the saw toothed. 1500 w. Am Mach—July 2, 1903. No. 56416.

Dividing Engines.

The Dividing of Circles in Mechanical Work (Die Ausführung von Kreisteilungen in der Maschinentechnik). F. von Handorff. A thesis at the Hanover Technical Highschool giving an illustrated descripton of methods and machnes for dividing circles. Serial. 5 Parts. 18000 w. Zeitschr f Werkzeugmaschinen u Werkzeuger—June 5, 15, 25, July 5 and 15, 1903. No. 56220 each D.

Drilling.

Experiments Upon the Work of Machine Tools. Forces and Work in Drilling (Experiences sur le Travail des Machines-Outils. Efforts et Energies de Forage). M. Codron. A continuation of the author's researches, containing a mathematical study, with many diagrams, of drilling and the power required to drill in various materials. 8000 w. Bull Soc d'Encour—June 30, 1903. No. 56933 G.

Fire Protection.

Fire Protection of Work Shops. J. W. G. Simonds. Considers such apparatus as may be useful to managers of small works to enable them to deal with an outbreak of fire. Ill. 5800 w. Page's Mag—July, 1903. No. 56593 B.

Fitting.

Allowances for Press and Running Fits and for Limits in Bored and Turned Work. Tables and explanatory notes giving the practice of the C. W. Hunt Co. in limits of workmanship for various kinds of work. 900 w. Am Mach—July 16, 1903. No. 56679.

Foundries.

A Modern Iron Foundry (Eine Moderne Eisengiesserei). Oscar Leyde. A well illustrated description of the construction, equipment and operation of the foundry of Ludw. Loewe & Co., Berlin. 4000 w. Stahl u Eisen—June 1, 1903. No. 56271 D.

The New Foundry of the Brown & Sharpe Mfg. Co. An illustrated detailed description of the recent addition to the plant at Providence, R. I. 2800 w. Mach, N Y—July, 1903. Serial. 1st part. No. 56405 C.

The New Foundry of the Sheffield Car Co., Three Rivers, Mich. Brief description, sectional and outline drawings. 500 w. Foundry—July, 1903. No. 56384.

Gauges.

Gauges in Workshops. Herbert J. Marshall. Read at the Engng. Con. of the Inst. of Civ. Engrs. A discussion of gauges and standards as affecting shop and manufactory administration. 2000 w. Engng—June 19, 1903. No. 56322 A.

Gear Cutting.

Automatic Wheel-Cutting Machine. Illustrated description of a machine capable

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of cutting spur, bevel, and worm gears. 1500 w. Engr, Lond—July 10, 1903. No. 56700 A.

The Art of Generating Gear Teeth. Howard A. Coombs. A review of the class of machines which "generate" the tooth curves, in contradistinction to those machines in which formed cutters or templets are used, previously shaped to the contour of the teeth. 2700 w. Am Mach—July 9, 1903. Serial. 1st part. No. 56622.

Interchangeable Devices.

Jigs and Fixtures for Interchangeable Manufacturing. Joseph V. Woodworth. An illustrated article considering the important factors, the various processes, etc. 3200 w. Ir Trd Rev—July 2, 1903. No. 56518.

Milling.

Milling as a Method of Machining. Charles S. Gingrich. An account of its development in American shop practice, giving illustrations and data showing what can be expected from the intelligent use of the modern milling machine. 4000 w. Cassier's Mag—July, 1903. No. 56603 B.

Molding.

Molding with Some Carving of Sand. R. H. Palmer. Describes the casting and the method used. 600 w. Am Mach—July 2, 1903. No. 56417.

Pattern Shops.

The Organization, Maintenance and Management of a Modern Pattern Shop. Jos. Leon Gobeille. Discusses remedies and improvements needed. Ill. 1800 w. Jour Am Found Assn—June, 1903. No. 56853.

Plate Straightening.

Plate-Straightening Rolls. Illustrated detailed description of machine constructed for the new armor-plate mills at Creusot. 600 w. Engng—June 19, 1903. No. 56310 A.

Riveted Joints.

A Table for Pitch and Efficiency of Riveted Joints. Philip B. Hill. Gives table prepared to facilitate the design of a riveted joint for any given case, explaining its use. 1000 w. Eng News—July 16, 1903. No. 56753.

Rivet-Holes.

Drilled v. Punched Rivet-Holes in the Hulls of Ships. A. F. Yarrow. Read at the Engng. Con. of the Inst. of Civ. Engrs. Gives results of experience thus far, describes and illustrates the methods of drilling, and strongly favors the drilling. 1400 w. Engng—June 26, 1903. No. 56485 A.

Shaft Couplings.

Dimensions for Flanged Shaft Couplings. S. H. Bunnell. Describes method used by a small shop in revising their whole set of patterns for flanged couplings with a view to consistency. 500 w. Am Mach—July 16, 1903. No. 56680.

Spelters.

Making Brazing Spelters. Walter J. May. Suggestions for making spelter by one operation with once heating. 400 w. Prac Engr—June 19, 1903. No. 56308 A.

Thread Cutting.

Tools and Methods for Accurate Thread Cutting. Jos. M. Stabel. An illustrated article describing the methods of a writer who has had large experience. 1500 w. Mach, N Y—July, 1903. No. 56406 C.

Wheels.

The Manufacture of Car and Locomotive Wheels and Tires (Beiträge zur Fabrikation der Eisenbahnräder und Bandagen). An illustrated description of the manufacture of wheels as carried out at one of the Krupp works, including solid steel wheels and various other kinds. 1500 w. Ill Zeitschr f Klein u Strassenbahnen —June 16, 1903. No. 56191 C.

Winding Machine.

Winding Machine for Coils of Flat Copper Ribbon. An illustrated description of a remarkable machine, the invention and design of Mr. John Riddell, which winds automatically and edgewise upon various forms. 1000 w. Am Mach—July 9, 1903. No. 56624.

MATERIALS OF CONSTRUCTION.

Alcohol Fuel.

Alcohol Considered as a Fuel (L'Alcool Considéré comme Combustible). Edmond Brunet. General considerations and statistics of prices and production of alcohol in Germany and France and its use as a fuel. 2600 w. Rev Technique—July 10, 1903. No. 56927 D.

Alloys.

An Introduction to the Study of Alloys. Prof. Henry M. Howe. A brief and very clear explanation of the modern theory of the constitution of metals, of its conclusions as affecting the materials of engineering construction, and of the methods of study and investigation by which the facts are established. Serial. 1st part. 4000 w. Ill. The Engineering Magazine—Aug., 1903. No. 56298 B.

Iron, Steel, and Other Alloys. First chapter of Prof. Henry M. Howe's new book on alloys. Ill. 4000 w. Metallographist—July, 1903. No. 56665 F.

Allovs of Iron, Nickel and Manganese. R. A. Hadfield. Read before the Engng. Con. of the Inst. of Civ. Engrs. Describes this alloy, which has shown remarkable properties. Gives results obtained in tests.

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700 w. Ir & Coal Trds Rev—June 26, 1903. No. 56492 A.

Alloys of Copper and Antimony (Les Alliages de Cuivre et d'Antimoine). M. Baykoff. A study of the properties of these alloys when cooling rapidly and slowly, with micrographs and diagrams. 1800 w. Bull Soc d'Encour—May 31, 1903. No. 56928 G.

Bronze.

An Account of Bronze Casting in Egypt, Europe and Japan. Randolph I. Geare. History of the art. 5500 w. Sci Am Sup —July 25, 1903. No. 56795.

Cast Iron.

Cast Iron for Dynamo and Motor Frames. H. E. Diller. Read at meeting of the Am. Soc. for Test Materials. Considers the requirements for use in dynamo and motor frames, and the problems it presents to the designer, especially as to its magnetic qualities. 1800 w. Ir Trd Rev—July 9, 1903. No. 56620.

On the Constitution of Cast Iron. Henry M. Howe. Read at meeting of the Am. Soc. for Test. Materials. A study of the relation between the composition and properties of cast iron. Ill. 9500 w. Metallographist—July, 1903. No. 56566 F.

Journal Brasses.

A Study of Alloys Suitable for Bearing Purposes. G. H. Clamer. Particularly a study of alloys suitable for railway journal bearings, considering composition, structure, friction, temperature of running, wear on bearing, wear on journal, compressive strength, and cost. Studies the combinations in present service. 7800 w. Jour Fr Inst—July, 1903. No. 56-393 D.

Nickel Steel.

The Metallography of Nickel Steel (La Metallographie des Aciers au Nickel). Dr. Léon Guillet. A micrographic study of the constitution and properties of nickel steel, in various proportions, with many illustrations. 6000 w. Bull Soc d'Encour —May 31, 1903. No. 56930 G.

Recent Researches in Nickel Steel (Nouvelles Recherches sur les Aciers au Nickel). Dr. Léon Guillet. An account of micrographic and other research work, with tables and diagram. 1600 w. Génie Civil—June 27, 1903. No. 56915 D.

Nickel-Steel. Crittenden Marriott. On the very peculiar qualities of this alloy, being nearly if not quite exempt from expansion and contraction through heat and cold, and also showing curious phenomena relating to magnetism, and the advantage in constructing surveying levels. 1600 w. Sci Am—July 11, 1903. No. 56655.

Specifications.

The Making of Specifications. Dr. C. B. Dudley. President's address before the Am. Soc. for Test. Materials. On the making of specifications for materials, describing the methods practiced at Altoona in connection with the laboratory of the Pennsylvania R. R., and giving the writer's views. 5700 w. Ir Age—July 9, 1903. No. 56537.

Springs.

Springs. William Metcalf. Read before the Am. Soc. for Test. Materials. Gives a short history of conditions and changes of the past 30 years in car and locomotive springs; the first specifications; those now used; the treatment, classes of springs, testing, etc. 5000 w. Ir Age—July 9, 1903. No. 56536.

Steels.

I. Dilatation of Steels at High Temperature. Georges Charpy and Louis Grenet. II. Transformation of Steel by the Dilatometric Method. Two papers by the same authors from *Comptes Rendus Academie des Sciences.* Experimental studies. 1200 w. Metallographist—July, 1903. No. 56-667 F.

MEASUREMENT.

Balance Lever.

The Balance Lever as a Calculating Machine. Ulrich Peters. Gives practical applications of the lever, with an illustrated description. 1400 w. Ir Age—July 23, 1903. No. 56775.

Curved Rods.

The Determination of the Stresses in Curved Rods (Zur Ermittelung der Spannungen Krummer Stäbe). Prof. M. Tolle. A mathematical discussion of the stresses in curved pieces, such as the links of chains, etc., with diagrams. 4500 w. Zeitschr d Ver Deutscher Ing—June 20, 1903. No. 56231 D.

Metric System.

The Metric Convention and the International Bureau of Weights and Measures (La Convention du Mètre et le Bureau International des Poids et Mesures). Ch. Ed. Guillaume. A continuation of the history of the metric system, with appendices giving accounts of important conventions and meetings, and record of the adoption of the metric system by various countries. 16000 w. Bull Soc d'Encour—June 30, 1903. No. 56934 G.

Shafts.

Calculations for Loaded Shafts Rotating at High Speeds (Méthode de Calcul des Arbres Chargés Animés de Grandes Vitesses de Rotation). M. Delaporte. Mathematical discussion of the forces acting on and the stresses in shafts of steam turbines, etc. Diagrams. 4000 w. Rev de Mécanique—June 30, 1903. No. 56935 E + F.

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Testing Laboratory.

The Testing Laboratory of the Conservatoire des Arts et Métiers (Le Laboratoire d'Essais du Conservatoire des Arts et Métiers). A. Dumas. An illustrated description of the new French national testing and research laboratory, connected with the famous conservatory of arts and trades. 2800 w. Génie Civil—July 11, 1903. No. 56919 D.

POWER AND TRANSMISSION.

Air-Compressor Explosions.

Accidents Due to Combustion Within Air-Compressors. E. Hill. Discussion of the paper of Dr. Albert R. Ledoux. A mathematical discussion of the heat of compression in air-cylinders. 1200 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 56763.

Air Compressors.

High-Speed Air Compressors (Ueber Kompressoren mit Erhöhten Umdrehzahlen). Hr. Harth. A discussion of the changes in steam-driven air compressors to give them higher speed, and of their efficiency. Diagrams. 1 Plate. 3500 w. Glückauf—Feb. 14, 1903. No. 56285 D.

Belt Driving.

Practical Belt Driving. John Tullis. Abstract of a paper read before the Aberdeen Mech. Soc. Discusses points of importance in belt driving, the power transmitted, slipping, compounding, high speed, kinds of belts, jointing, dressing, etc. 5800 w. Mech Engr—July 11, 1903. No. 56711 A.

Coal Handling.

Coal Handling Machinery and Its Application to Steam Power Plants. T. F. Webster. Discusses particularly the methods of mechanically handling coal in steam power plants, and other classes in connection with such plants. Ill. 6000 w. Pro Engrs Soc of W. Penn—May, 1903. No. 56858 D.

Automatic Machinery for Handling Coal. Day Allen Willey. Illustrates and describes various forms of conveying machinery. 1200 w. Sci Am—July 4, 1903. No. 56465.

Cranes.

Hoisting Apparatus at the Düsseldorf Exposition (Die Hebezeuge auf der Düsseldorfer Ausstellung). S. Fraenkel. A paper before the Verein Deutscher Maschinen-Ingenieure, giving an illustrated account of large traveling cranes and other kinds of hoisting machinery. Serial. Part I. Tables. 2500 w. Glasers Annalen—July 1, 1903. No. 56243 D.

Cranes on Dover Pier. An illustrated description of the special cranes installed to facilitate the handling of baggage and mails, with report of the official trials. 1100 w. Engr, Lond—July 17, 1903. No. 56814 A.

Economical Speeds of Cranes. Archibald Potter Head. Read before the Engng. Con. of the Inst. of Civ. Engrs. On the speeds of overhead and other cranes as a factor in economical handling of material in working, dealing with the different designs seriatim. 2000 w. Engng—June 19, 1903. No. 56320 A.

Portable Pneumatic Revolving Cranes. Illustrates and describes a special form of locomotive crane designed to be operated with compressed air. 900 w. Eng News—July 23, 1903. No. 56846.

See also Electrical Engineering, Power Applications.

Flywheels.

Flywheels. William H. Boehm. Considers the more frequent causes of flywheel disruptions, discussing points of interest in connection with the design and operation of flywheels of various types. 2400 w. Engr, U S A—July 15, 1903. Serial. First part. No. 56741 C.

Gears.

Investigation of a Three Thread Worm Gear. E. Bach and E. Roser. Translated in abstract, from the *Zeitschrift der Vereines Deutscher Ingenieure*, by E. P. Buffet. Describes experiments made at the engineering laboratory of the Royal Tech. High School, Stuttgart. Ill. 1400 w. Am Mach—July 16, 1903. Serial. 1st part. No. 56681.

Lubrication.

Friction and Lubrication. J. Stormonth. References to the light gained through the experiments of Mr. Towers, Prof. Goodman and others, is made and points bearing on this subject discussed. 3500 w. Engr, Lond—June 19, 1903. No. 56331 A.

Screw Conveyor.

A 650-foot Screw Conveyor (Transport par Hélices à 200 Mètres de Distance). An illustrated description of a helical conveyor, worked in sections by a steel cable, for transporting the pressed material from a beet-sugar factory to canal boats or wagons. 1000 w. Génie Civil—May 30, 1903. No. 56907 D.

Slag Conveyor.

A New Cupola Slag Conveyor. Thomas D. West. Brief illustrated description. 300 w. Jour Am Found Assn—June 1903. No. 56855.

Tightening Pulley.

Transmission of Motion by Belts or Cables by Means of the Leneveu Tightening Pulley (Transmissions de Mouvement par Courroies ou Cables. Enrouleur-Debrayeur du Capitaine Leneveu). Ch. Dantin. An illustrated description of power transmission in general, and particularly,

of the Leneveu balanced tightening pulley, which greatly increases the arc of contact of belt or rope. 3500 w. Génie Civil —June 20, 1903. No. 56912 D.

SPECIAL MOTORS.

Bavaria.

See Mechanical Engineering, Miscellany.

Canal-Boat Motors.

See Marine and Naval Engineering.

Dynamo Driving.

Internal-Combustion Engines for Driving Dynamos. Herbert A. Humphrey. Read at the Engng. Con. of the Inst. of Civ. Engrs. Considers the types of gas-engines now made for driving dynamos, giving figures showing the number of impulses per revolution and the horse-power up to which each type is constructed. 2800 w. Engng—June 19, 1903. No. 56321 A.

Gas Engines.

Power and Economy of the Gas Engine as Influenced by the Fuel. William P. Flint.. A short paper discussing the commercial gases, followed by general discussion. 2500 w. Pro Engrs Soc of W Penn—May, 1903. No. 56857 D.

Contributions to the Design of Gas Engines (Beiträge zur Berechnung der Gasmaschine). Rudolf Barkow. A discussion, with formulæ and diagrams, of some points in the theory and design of gas engines. 1500 w. Zeitschr d Ver Deutscher Ing—June 27, 1903. No. 56235 D.

Air and Gas Mixtures, Explosion Pressures, and Cylinder Proportions of Gas Engines. James Dunlop. Gives method of determining the above points, devised by the writer, and agreeing closely with practice. 1600 w. Mech Engr—July 18, 1903. No. 56805 A.

Butler's 5,000 H. P. 3-Cylinder Double-Acting Compound Gas Engine. Illustrations and particulars of a vertical engine designed by Edward Butler. 800 w. Mech Engr—June 20, 1903. No. 56347 A.

Management of the Gas Engine. A. Stritmatter. Hints on the proper oiling, need of cleanliness, etc. 1800 w. Gas Engrs' Mag—July 10, 1903. No. 56804 A.

Gas Engines Using Producer Gas (Gasmaschinen für Generatorgas). R. W. Hilgenstock. A paper before the Technischer Verein of Philadelphia, giving a general illustrated account of gas engines and their development. 3000 w. Technologist—April, 1903. No. 56195.

Igniter.

See Electrical Engineering, Miscellany.

Oil-Engines.

The Britannia Oil Engine. Illustrated description of the Nicholson engine, in which no external source of heat is used in vaporizing the oil, but is capable of running for long periods under light load. 900 w. Engng—June 19, 1903. No. 56311 A.

The Kynoch-Forward Oil-Engine. Illustrated description of a new design, with report of trial. 1600 w. Engng—June 19, 1903. No. 56313 A.

STEAM ENGINEERING.

Bavaria.

See Mechanical Engineering, Miscellany.

Blowing Engines.

Notes on Steam-Driven and Gas-Driven Blowing-Engines. Tom Westgarth. Read before the Engng. Con. of the Inst. of Civ. Engrs. Considers these engines individually, and also the question as to which type is more economical and more suitable for the work. 1500 w. Engng—June 19, 1903. No. 56326 A.

Boiler Testing.

Engine and Boiler Testing. W. H. Booth. A discussion of methods of testing and their value. 2000 w. Mach, N Y —July, 1903. No. 56407 C.

Coal-Dust Fuel.

Coal-Dust Burning Process. C. O. Bartlett. Read at meeting of Engrs.' Club of Cleveland. Considers things necessary to obtain satisfactory results, the advantages to be gained and the obstacles to be met. 2000 w. Ry & Engng Rev—July 25. 1903. No. 56850.

The Combustion of Lean Coal Dust (Ueber Verfeuerung von Magerfein-Kohlen). H. Schäfer. A discussion of grates and methods of firing for very small sizes of lean coal. 1000 w. Glückauf—June 20, 1903. No. 56293 D.

Condensation.

A Novel Method of Air-Cooling. Arthur Pennell. Illustrates and describes devices for dissipating the latent heat of condensed steam into the atmosphere by utilizing the ability of the air to absorb water vapor. 2200 w. Engr, U S A—July 15, 1903. No. 56743 C.

Condensing Plants.

Central Condensation Plants at the Düsseldorf Exposition (Les Condensations Centrales à l'Exposition de Düsseldorf). P. F. Dujardin. A well illustrated description of cooling towers and other steam-condensing apparatus. 1 Plate. 2200 w. Génie Civil—May 30, 1903. No. 56905 D.

The Mars Vertical Displacement Air Pump. An illustrated description of the Thomas and Marsland's patent condensing plant. 500 w. Engr, Lond—June 26, 1903. No. 56494 A.

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Condensing Plant for Central Electric Stations. R. D. Summerfield. Illustrates and describes some of the modern arrangements and discusses the subject generally. 2200 w. Engng—July 17, 1903. Serial. 1st part. No. 56818 A.

Engine Drawings.

Drawings of Modern Triple-Expansion Engines. Gives a set of working drawings of a modern triple-expansion engine of the vertical inverted cylinder, direct-connected, triple-expansion type, explaining the correct names of the different parts. 700 w. Marine Engng—July, 1903. No. 56425 C.

Engine Stops.

An Improved System of Engine Stops. An illustrated description of the Monarch system which works automatically. 2000 w. Sci Am Sup—July 11, 1903. No. 56662.

Evaporators.

See Marine and Naval Engineering.

Feed-Water Heater.

McBride's Locomotive Feed Water Heater. Illustration and statement of the advantages of this system, invented by T. C. McBride. 1700 w. R R Gaz—July 17, 1903. No. 56754.

Feed-Water Purifiers.

New Controller of Boiler Water. Description, with illustrations, of an apparatus used on Dutch steamers and in Dutch factories where carbonate of soda is added to the water to prevent incrustation. 1200 w. U. S. Cons. Reports. No. 1699—July 17, 1903. No. 56645 D.

The Harris-Anderson Water Softener. Illustrated description of this apparatus and its operation. 2300 w. Enging—July 10, 1903. No. 56704 A.

Four Systems of Softening Water for Industrial Purposes. Illustrated descriptions of the Pittsburg, New York-Continental Jewel, Breda and Tweeddale systems respectively. 3800 w. Eng News—July 2, 1903. No. 56414.

Liquid Fuel.

Liquid Fuel for Power Purposes. Arthur L. Williston. A thorough presentation of the economic side of the question, with figures and diagrams showing the fluctuation of production and price over long periods, and an estimate of the future supply of fuel oil. Illustrated. 3200 w. The Engineering Magazine—August, 1903. No. 56904 B.

Lubrication.

Cylinder Oil and Cylinder Lubrication. Henry M. Wells. An article dealing with cylinder oil for steam engines. How to find the best oil for given working conditions. Gives a general outline of the process of manufacture and treatment of cylinder oil. 2500 w. Engr, Lond—July 17, 1903. Serial. First part. No. 56809 A.

Piping.

High Pressure Steam Piping. William Andrews. Read before the Engine B'ldrs Assn. of the U. S. Reviews the progress during the last twenty-one years, and describes present practice, considering design, quality of material and the method of disposing of the water of condensation. 2200 w. Power—July, 1903. No. 56410 C.

Pressure-Reducing Valves.

Valves for Reducing Steam Pressures (Das Dampfdruckminderungsventil). Siegfried Mertens. A discussion of means for perfecting steam pressure reduction valves and calculating their performance. 2500 w. Gesundheits-Ingenieur—May 10, 1903. No. 56197 B.

Rolling-Mill Engine.

The Reconstruction of a Twin Reversing Rolling Mill Engine, with Rattmann Valve Gear (Umbau einer Zwillings-Reversiermaschine mit Rattmann Steuerung). An account of the conversion of a twin reversing engine into a tandem compound, with a consequent saving in steam. Indicator diagrams. 1 plate. 600 w. Stahl u Eisen—July 1, 1903. No. 56279 D.

Rotary Engines.

The Warren Rotary Engine. An illustrated detailed description of the engine and its operation. 2200 w. Ir Age—July 9, 1903. No. 56535.

Smoke Prevention.

Steam Jets for Preventing Smoke. R. H. Palmer. Illustrates and describes a blower in use at the works of William Allen & Sons Co., Worcester, Mass., and its satisfactory working. 700 w. Am Mach—July 2, 1903. No. 56418.

Smoke Abatement. George Thomas Beilby. Read at Engng. Con. of the Inst. of Civ. Engrs. Refers to subjects now being investigated which will have a bearing on the question, and suggests that a tax be levied on the use of smoke-producing fuel. Gives interesting information. 1400 w. Engng—June 26, 1903. No. 56489 A.

Steam Engines.

The 4,000-Horse Power Engines at the Third Avenue, Brooklyn, Power House. An illustrated detailed description of these engines. The present installation comprises 8 4,000-h. p. engines direct-connected to both direct and alternating current generators. They are arranged in four pairs. 2300 w. Power—July, 1903. No. 56408 C.

Steam Heating.

Description of a Low-Pressure Steam Heating System which Proved Defective in Operation. John Gormly. Read at

meeting of Am. Soc. of Heat and Ven. Engrs. Description of the plant which was installed. 1600 w. Met Work—July 25, 1903. No. 56800.

The Regulation of Low Pressure Steam-Heating Systems (Die Erzielung der Generellen Regelung der Niederdruck-dampfheizungen). Prof. Rietschel. A mathematical and experimental discussion of the proper diameter of pipes and of the general regulation of pressure and heating in steam heating systems. 4000 w. Gesundheits-Ing—June 20, 1903. No. 56-200 B.

Steam and Its Application to the Heating of Railway Carriages. A paper read by Mr. Claypool before the British Inst. of heat and Ven. Engrs. on the heating and ventilation of railway cars, the systems in use, &c. General discussion follows. 4000 w. Dom Enging—July 25, 1903. No. 56826 C.

Steam-Heating Station.

The Royal Central Heating and Electric Station at Dresden (Königliches Fernheiz- und Elektrizitätswerk zu Dresden). R. Trautmann. An illustrated description of a large central steam heating plant, in an ornamental building, for heating the principal public buildings in Dresden, Germany. 1 plate. 5000 w. Glasers Annalen—July 15, 1903. No. 56245 D.

Heat and Electric Light Distribution in Dresden. C. Arldt. Illustrates and describes the installation of the Dresden heating and electric light generating station, which supplies heat and light to royal, municipal and other buildings. 2200 w. Trac & Trans—June, 1903. No. 56306 E.

Steam Loop.

A Few Points on the Steam Loop. H. H. Kelley. Read before the Ohio Soc. of Mech., Elec. and Steam Engrs. Explains this arrangement of piping and its principle of operating, illustrating by examples. 2000 w. Engr, U S A—July 1, 1903. No. 56549 C.

Steam Turbines.

Steam Turbines. Prof. Rateau. Remarks showing the possibilities of steam turbines, and describing some recent designs. 1000 w. Prac Engr—June 26, 1903. No. 56476 A.

The Rateau Steam Turbine. Illustrations, with description of the construction of the machine, and an account of the principles and tests. 2000 w. Elec Wld & Engr—July 25, 1903. No. 56837.

The Steam Turbine (La Turbine a Vapeur.) M. Raucour. A general review of steam turbines, principally of the Parsons type, for driving electric generators, with results of operation. 4000 w. Rev Technique—May 25, 1903. No. 56920 D.

Steam Turbines (Les Turbines a Vapeur). A. Abraham. Illustrated. General review. Serial. Part 1. 1200 w. Rev Technique—July 10, 1903. No. 56-926 D.

Notes on Parson's Steam Turbines (Mitteilungen über Parsons-Dampfturbinen). Hans Dominik. An illustrated description of various steam turbine plants in Germany, France and Switzerland, and results of tests. 3000 w. Ill Zeitschr f Klein u Strassenbahnen—April 1, 1903. No. 56186 C.

See Also Marine and Naval Engineering.

Superheating.

Progress in the Use of Superheated Steam (Fortschritte in der Anwendung des Ueberhitzten Dampfes). A paper by Director Burkhardt before the "Eisenhütte Oberschlesien," giving a general account of the application of superheated steam for engines and of superheating systems. Serial. Part 1. 5000 w. Stahl u Eisen—July 15, 1903. No. 56281 D.

A Century of Superheated Steam. E. P. Watson. Explains the term; discussing the difficulties encountered in its use, and its value. 2500 w. Ir Age—July 16, 1903. No. 56683.

Some New Types of Superheaters. Prof. W. H. Watkinson. Read before the Inst. of Naval Archts. Illustrates and describes various superheaters designed by the author, which are giving exceedingly satisfactory results. Briefly explains the objects and advantages of superheating. 5000 w. Enging—July 10, 1903. No. 56707 A.

Thermodynamics.

A New Theory of Heat Power Plants. Robert H. Smith. The first of a series of articles on the relation of heat to mechanics. 3500 w. Engr, Lond—July 10, 1903. Serial. First part. No. 56698 A.

Valves.

Replacing a Slide Valve with a Piston Valve. J. P. Badenhausen. Describes the method of making the change, and explains why it was undertaken. Ill. 1100 w. Marine Enging—July, 1903. No. 56-433 C.

Waste Steam.

Utilizing the Waste Steam from Winding Engines. Translated from *Glückauf*. Illustrated description of an interesting device recently installed in a colliery at Bruay (Pas-de-Calais). 800 w. Col Guard—June 26, 1903. No. 56484 A.

MISCELLANY.

Aeronautics.

The Balloon "Lebaudy" (Le Ballon "Lebaudy"). Lieut. Col. G. Espitallier A well illustrated description of a long

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balloon with a flat under surface, rudders and propellers, which has made successful trips in France. 6000 w. Génie Civil—June 13, 1903. No. 56911 D.

The New Santos-Dumont Airships. An illustrated article reporting the performance of No. 9, and describing features of interest. 1200 w. Sci Am—July 11, 1903. No. 56656.

The Sahara Aeronautical Experiments at Gabes, Tunis (Les Experiences Aérostatiques Sahariennes de Gabes). Leo Dex. Illustrated account of the sending of an experimental balloon across part of the Sahara desert, from Gabes, Tunis. Serial Part 1. 1300 w. Rev Technique—June 25, 1903. No. 56924 D.

Scientific Kite Flying. W. H. Dines. An illustrated account of experiments made in flying kites from the deck of a steam vessel stationed on the west coast of Scotland. 1800 w. Nature—June 18, 1903. No. 56340 A.

The Spontaneous Combustion of Balloons Upon Landing (Sur l'Incendie Spontané de Ballons Pendant l'Atterrissage). W. de Fonveille. An account of explosions presumably caused by the balloon acquiring an electric charge and being discharged when the aeronaut steps on the ground and touches the valve rope. 600 w. Comptes Rendus—May 11, 1903. No. 56944 D.

Agricultural Machinery.

The Royal Show. An account of the 64th annual exhibition of the Royal Agricultural Society, giving illustrated descriptions of interesting exhibits. 3800 w. Engr, Lond—June 26, 1903. Serial. First part. No. 56497 A.

Bavaria.

The Historical Development of Engineering in Southern Bavaria (Die Geschichtliche Entwickelung der Technik im Südlichen Bayern). P. v. Lossow. A general historical and descriptive review of technical progress, with illustrations. 16000 w. Zeitschr d Ver Deutscher Ing—July 4, 1903. No. 56236 D.

New Products of the Munich and Augsburg Engine Industry (Neure Leistungen der München—Augsburger Maschinenindustrie). Prof. M. Schröter. An illustrated account of locomotives, compressors, Diesel motors and other engines manufactured in these Bavarian cities. 6000 w. Zeitschr d Ver Deutscher Ing—July 11, 1903. No. 56239 D.

Drawing Office.

Some Features of the Drawing Office System of the C. W. Hunt Company. Description, with illustrations. 1600 w. Am Mach—July 9, 1903. No. 56623.

Gravitation.

The Mechanical Cause of Gravitation. Robert Stevenson. An experimental study. 1600 w. Elec Wld & Engr—July 11, 1903. No. 56640.

Heating and Ventilation.

The Heating and Ventilation of Foundries and Machine Shops. W. H. Carrier. States the difficulties to be overcome and shows the adaptation of the fan system to the solution. Ill. 2800 w. Jour Am Found Assn—June, 1903. No. 56854.

Heating and Ventilating the Machine Shop. J. I. Lyle. On the utilization of exhaust steam for heating, considering the three systems adapted to its use. 2500 w. Can Engr—July, 1903. No. 56509.

The Economical Heating of Railway Repair Shops. W. H. Carrier. Explains the difficulties to be overcome in the heating of shop buildings, and offers suggestions as to general methods of air distribution. Ill. 2700 w. Ry Age—June 30, 1903. (Daily Ed.) No. 56514.

See also Mechanical Engineering, Steam Engineering.

Heat Radiators.

The Scientific Basis and Commercial Feasibility of Heat Radiators, Using Air Instead of Water or Steam. George M. Aylesworth. Read at meeting of Am. Soc. of Heat & Ven. Engrs. Describes the system as adopted by the writer and its successful application to house warming. Ill. 2300 w. Met Work—July 25, 1903. No. 56799.

Phonograph Records.

Moulded Records for Phonographs. An illustrated article describing fully the making of master records, and the mold from which duplicates are made. 2200 w. Am Mach—July 9, 1903. No. 56621.

Refrigeration.

Cooling of Dwellings. Alfred Siebert. Explains a system of artificial cooling, and how to control humidity, etc. 1800 w. Ice & Refg—July, 1903. No. 56517 C.

United States.

A Journey in the United States for the Purpose of Studying the Mechanical Industries (Eine Studienreise in den Vereinigten Staaten von Amerika). Paul Möller. An account of American technical and industrial conditions, as seen on a trip through the United States by a representative of the Verein Deutscher Ingenieure. Serial. 2 Parts. 7000 w. Zeitschr d Ver Deutscher Ing—July 4 and 11, 1903. No. 56237 each D.

Windmills.

Windmills. Sidney Russell. An illustrated review of the old type of windmills, now disappearing. 11400 w. Trac & Trans—June and July, 1903. Serial. 2 Parts. No. 56304 each E.

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MINING AND METALLURGY

COAL AND COKE.

Analysis.

The Determination of Sulphur in Coal. Charles W. Stoddart. Abstract from the *Jour. Am. Chem. Soc.* Gives details of the various methods used, describing the standard method. 2000 w. Eng & Min Jour—June 27, 1903. No. 56441.

British Columbia.

Coal Production of British Columbia. Information from the annual report of the Minister of Mines. 3000 w. Col Guard—July 3, 1903. No. 56577 A.

Coal-Cutting Machines.

Coal-Cutting Machines (Haveuses Mécaniques Employées dans les Mines de Houille). J. Rosset. Illustrated descriptions of many kinds of drills and other coal-cutting machinery. Serial. Part 1. 1600 w. Génie Civil—July 4, 1903. No. 56918 D.

Experiments With Percussive Coal-Cutting Machines (Versuche mit Stossenden Schrämmaschinen). Hr. Brandi. An account of tests of coal-mining machines acting by percussion and using compressed air, in the Dortmund district, Germany. Tables. 1000 w. Glückauf—July 4, 1903. No. 56296 D.

Coal-Cutting Machinery. H. Baddeley. Read before the Nat. Assn. of Colliery Mgrs. Gives the writer's experience in this field, discussing the conditions favorable and unfavorable to the use of machinery and other points of interest. 3800 w. Ir & Coal Trds Rev—July 17, 1903. No. 56824 A.

Notes on Percussive Coal-Cutters. Sir Thomas Wrightson and John Morison. Read at the Engng. Con. of the Inst. of Civ. Engrs. Discussion of why these machines which have proven profitable in America, have not been so considered in England. Describes a machine designed by the writers to meet British conditions. 1800 w. Engng—June 19, 1903. No. 56-323 A.

Coal Cutting by Machinery. J. W. Chubb. Discusses the advantages of mechanical coal cutters, and reviews their history. Gives illustrated descriptions of various types. 5000 w. Fielden's Mag—July, 1903. No. 56592 B.

Coal Mining.

Wages and Profits in Coal Mining. Tabulated statistics from a pamphlet issued by the British Board of Trade showing the quantity and value of coal produced in the United Kingdom and the number and average wages of coal miners, etc. 1800 w. Ir & Coal Trds Rev—June 19, 1903. No. 56333 A.

Exhibition.

International Colliery Exhibition. A comprehensive illustrated description of the various exhibits at the Agricultural Hall, London. 10800 w. Col Guard—July 10, 1903. Serial. First part. No. 56693 A.

The Colliery Exhibition at the Royal Agricultural Hall, London. Brief illustrated descriptions of some of the more interesting exhibits. 16000 w. Ir & Coal Trds Rev—July 3, 1903. No. 56589 A.

Explosions.

Dusty Shots as a Factor in Coal Dust Explosions. Henry S. Munroe. Gives instances showing that dusty shots, in combination with blown-out shots, must be taken into serious consideration in devising means for preventing such explosions. 3500 w. Eng & Min Jour—June 27, 1903. No. 56438.

Firedamp Explosions in the Dortmund District, Germany, With Relation to the State of the Barometer in 1902 (Die Schlagwetter-Explosionen im Oberbergamtsbezirk Dortmund mit Beziehung auf den Barometerstand im Jahre 1902). Statistics and discussion of the relation between firedamp and atmospheric pressures. 1 Plate. 1200 w. Glückauf—June 13, 1903. No. 56292 D.

Fossils.

Codonotheca, a New Type of Spore-Bearing Organ from the Coal Measures. E. H. Sellards. An illustrated description of a peculiar type of fructification. 4000 w. Am Jour of Sci—July, 1903. No. 56382 D.

German Iron Works.

The Acquisition of Coal Mines in the Ruhr District, Germany, by Iron Companies (Erwerbung von Steinkohlengruben im Ruhrkohlenbezirk durch Hüttenwerke). Hr. Hundt. An account of the increasing ownership of their own coal mines by iron works, and a discussion of general effects of this practice. 5000 w. Stahl u Eisen—July 1, 1903. No. 56277 D.

Handling Coal.

See Mechanical Engineering, Power and Transmission.

Hauling.

Notes on the Utilization of Surplus Power in a Self-Acting Incline at Redheugh Colliery. C. H. Steavenson. Describes a method of hauling coals by means of the surplus power derived from

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a self-acting incline. 1500 w. Ir & Coal Trds Rev—July 3, 1903. No. 56590 A.

Mules.

Care and Protection of Mules in Mines. Gives rules and regulations issued to employees by the Delaware & Hudson Co. at Scranton, Pa. 3800 w. Mines & Min—July, 1903. No. 56377 C.

Peat.

Peat Fuel. W. H. Booth. Discusses the possibility of the peat industry in Ireland, stating what has been accomplished in Germany. 3500 w. Eng, U S A—July 1, 1903. No. 56547 C.

Queensland.

Queensland Coal Mines. Information from the annual report of W. Fryar, Inspector of Mines. Ill. 5500 w. Queens Gov Min Jour—May 15, 1903. No. 56379 B.

COPPER.

Arizona.

The Shannon Copper Mine and Other Properties. T. F. Swanwick. Illustrations and description of the mines in the Clifton region. 2500 w. Pacific C Min—July 4, 1903. No. 56608.

British Columbia.

Mount Sicker Mining District, British Columbia. W. M. Brewer. Gives the history of these copper mines, their development, geology, treatment, etc. 3800 w. Min & Sci Pr—July 4, 1903. No 56618.

Copper-Matte.

Relative Elimination of the Impurities in Bessemerizing Copper-Matte. W. Randolph Van Liew. Gives results obtained in determining the relative rate and in finding the point where different impurities are eliminated. 700 w. Trans Am Inst of Min Engrs—October, 1903. No. 56765.

Mansfeld.

The Report of the Mansfeld Copper Company, of Eisleben, Germany, for 1902 (Verwaltungsbericht der Mansfeldschen Kupferschiefer Bauenden Gewerkschaft zu Eisleben für das Jahr 1902). An abstract of the report of this great copper and silver mining company, giving production and financial statistics. 1500 w. Glückauf—May 16, 1903. No. 56287 D.

Metallurgy.

Notes on the Metallurgy of Copper of Montana. Prof. H. O. Hofman. Condensed account of past and present plants, the ores, metallurgical treatment, melting, converting copper-matte, electrolytic refining, etc. 1800 w. Trans Am Inst of Min Engrs—February, 1903. No. 56770 D.

Review of the Recent Progress in the Metallurgy of Copper. Stuart Croasdale. Remarks on the metallurgy of the sulphide ores of copper, showing a record of most rapid advancement. 4800 w. Pacific C Min—June 27, 1903. No. 56500.

Michigan.

Copper Mining in Upper Michigan. J. F. Jackson. Read at a meeting of the West. Soc. of Engrs. An illustrated description of the region, the mines, and some of the methods and machinery used. 6000 w. Mines & Min—July, 1903. No. 56372 C.

Queensland.

The Garnet-Formations of the Chillagoe Copper Field, North Queensland, Australia. George Smith. Describes this field and the deposits, particularly the secondary deposits connected with the garnet. Ill. 3000 w. Trans Am Inst of Min Engrs—October, 1903. No. 56762.

Utah.

The Premier Copper Camp of the Wasatch Mountains. Henry M. Adkinson. An illustrated account of mining operations at Bingham, Utah. The ores are copper, copper-iron sulphides and galena. Gold, silver and zinc are present. 6800 w. Pacific C Min—June 20, 1903. No. 56365.

The Copper Deposits of the Beaver River Range, Utah. Henry M. Crowther. Describes the deposits of this region. 1200 w. Eng & Min Jour—June 27, 1903. No. 56439.

Wyoming.

Silver Crown Copper District. An illustrated article describing the extensive development work in progress by the Hecla Gold and Copper Mining, Milling and Smelting Company. 1700 w. Min Rept—July 16, 1903. No. 58779.

GOLD AND SILVER.

Briquetting.

Briquetting Precious Mineral Ores. William G. Irwin. Reviews briefly what has been accomplished, especially in America. 1200 w. Sci Am—July 11, 1903. No. 56659.

California.

Observations on Mother-Lode Gold-Deposits, California. William A. Pritchard. A study of the geology of these deposits. 4500 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 56766.

Colorado.

A Promising Gold Field, and Tests by Sampling. An illustrated account of the deposits on the Trinchera Estate in Costilla Co., Colo., consisting of beds of gold-bearing quartzite. Also a discussion of methods of sampling, and the best method of procedure. 1700 w. Eng & Min Jour—July 18, 1903. No. 56730.

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Cripple Creek.

The Bottom Levels at Cripple Creek. George J. Bancroft. Gives a statement of the experience of a number of representative mines. 2800 w. Eng & Min Jour—July 18, 1903. No. 56728.

Cyanide Process.

The Synthetic Cyanide Process. Dr. Fritz Roessler. Extract from a paper read at the Berlin International Cong. of Ap. Chem. Brief comment on the four processes furnishing mainly the world's supply—the Siepermann, the Beilby, the Raschen, and the improved Castner process. 500 w. Jour Gas Lgt—July 14, 1903. No. 56788 A.

Estimation of Cyanide in Cyanide Solutions. J. E. Clennell. Abstract of paper read before the Inst. of Min. & Met., London. Gives method of estimating free cyanide, and also methods of estimating "total cyanide." 1400 w. Eng & Min Jour—July 4, 1903. No. 56528.

A Secondary Reaction in Cyaniding. Dr. J. Ohly. A study of causes that explain the difference in results in the laboratory and in actual practice, with explanations of secondary, partial, and reversible reactions and other points bearing on this subject. 1800 w. Min Rept —July 2, 1903. No. 56503.

Cyaniding in Montana. Matt. W. Alderson. Discusses what the process is; how, and to what ores it may be applied; giving some facts, and costs. 2800 w. Mines & Min—July, 1903. No. 56373 C.

Cyaniding in the Black Hills, S. D. J. B. Empson. Describes a type of the wet-crushing mills of this district. 1600 w. Min & Sci Pr—June 27, 1903. No. 56521.

Cyaniding Sulpho-Telluride Ores. Philip Argall. Compares the method of working ores in the raw state, by means of fine grinding and subsequent treatment with bromocyanide, known as the Diehl process, with the roasting method as practiced on the ores of Cripple Creek. 2000 w. Eng & Min Jour—July 11, 1903. No. 56631.

The Cyaniding of Some Silver Ores by Percolation. Andre P. Griffiths and Frank W. Oldfield. Abstract from the Pro. of Inst. of Min. & Met., London. Notes on results obtained in the cyanide treatment of low-grade ores of the Palmarejo Mines, in Mexico, which have proved commercially successful. 2000 w. Eng & Min Jour—July 18, 1903. No. 56731.

See also Industrial Economy.

Gold Dredging.

Dredging in the Ovens Valley. General remarks on dredging work, with illustrated description of the plant of the Ovens Valley Gold Dredging Co., Victoria. 2200 w. Aust Min Stand—June 11, 1903. No. 56553 B.

Mercur's Mines.

No Gold in Limestone an Exploded Theory. L. H. Beason. Reviews the history of these Utah mines and the methods used, and considers that there is no reason why they should not continue to be dividend payers. Ill. 2500 w. Pacific C Min—June 27, 1903. No. 56499.

Milling Costs.

Gold Milling Costs. S. Horsley. States the difficulties in the way of a proper comparison of the total cost of extraction on the various gold-fields, giving information and a comparative table of gold milling and mining costs. 2000 w. Queens Gov Min Jour—May 15, 1903. No. 56-378 B.

Ore Treatment.

Filter-Press Treatment of Gold Ores and Slimes by Cyanide. An account of improvements made in this process and the success attained. Suggestions for the proper treatment of different varieties of ore. 4000 w. Min & Sci Pr—July 4 and 11, 1903. Serial. 2 Parts. No. 56617.

Quartz Milling.

Notes on the Common Practice of Quartz Milling on the Rand. Fraser Alexander. Discussion of this paper. 5500 w. Jour Chem & Met Soc of S Africa—May, 1903. No. 56575 E.

Samples.

A New Wet Sampler. Edgar Smart. Drawings and description of a new design invented by J. Higham. 1500 w. Page's Mag—July, 1903. No. 56595 B.

San Juan.

Across the San Juan Mountains. T. A. Rickard. An account of the mining districts of these Colorado mountains. The present article gives information of the American Nettie mine, and the Bachelor mine. Ill. 1700 w. Eng & Min Jour —July 4, 1903. Serial. 1st Part. No. 56524.

Silver-Lead.

Santa Eulalia Mines. Prof. Arthur Lakes. A trip to the ancient and very rich silver-lead mines in the Santa Eulalia mountains, near Chihuahua, Mexico, is illustrated and described. 2300 w. Mines & Min—July, 1903. No. 56370 C.

Transvaal.

Mining in South Africa. I.—The Transvaal Gold Production. J. H. Curle. Considers it certain that this region will stand first in production, and begins a study of the mining industry of South Africa, and the conditions to be met. 1800 w. Eng & Min Jour—July 11, 1903. Serial. 1st Part. No. 56628.

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Recent Improvements in Gold Mining Machinery on the Rand. Arthur E. T. Lees. Read before the Engng. Con. of the Inst. of Civ. Engrs. Describes improvements made in haulage, boiler plants, stamp mills, mill-engines, winding-engines, rock-drilling, mine pumps, etc. 1400 w. Engng—June 19, 1903. No. 56324 A.

IRON AND STEEL.

Africa.

The Iron Ore Deposits of Northwest Africa (Die Eisenerzlagerstätten Nordwestafrikas). Hr. Baum. An illustrated account of iron ore deposits and mines in Morocco, Algiers and Tunis. Map. 1 Plate. 7000 w. Stahl u Eisen—June 15, 1903. No. 56273 D.

Blast-Furnace Explosions.

Blast-Furnace Explosions With Falling Charges (Hochofenexplosionen beim Stürzen der Gichten). Bernhard Osann. A discussion of the causes of blast-furnace explosions. 2800 w. Stahl u Eisen—July 1, 1903. No. 56280 D.

The Cause of Some Blast Furnace Explosions. Extract from a paper by Director Schilling at meeting of the Verein Deutscher Eisenhuettenleute. Explains his view as to the cause of explosions following "hanging." 1500 w. Ir Age—July 2, 1903. No. 56421.

Blast-Furnace Products.

Blast-Furnace By-Products and Their Possible Recovery. Horace Allen. Gives a list of the by-products, the profitable recovery of which has been demonstrated, and considers them seriatim. Ill. 3500 w. Feilden's Mag—July, 1903. No. 56-591 B.

Blast Furnaces.

The Equalization of Hot-Blast Temperatures for Blast-Furnaces. Joseph Hutchinson Harrison. Read at the Engng. Con. of the Inst. of Civ. Engrs. Describes an apparatus known as an "equalizer" and its action. 900 w. Engng—June 19, 1903. No. 56325 A.

Gas Analysis Calculation of a German Blast Furnace Producing Grey Foundry Iron (Gasanalytische Durchrechnung eines Deutschen Hochofens auf Graues Giessereiroheisen). Dr. C. Waldeck. An analytical investigation of the raw materials entering into and the gases and other products coming from a blast furnace. 2000 w. Stahl u Eisen—June 1, 1903. No. 56272 D.

Cast Iron.

See Mechanical Engineering, Materials of Construction.

Charging Apparatus.

Recent Electric Charging Appliances for Open-Hearth Furnaces (Ueber Neuere Elektrisch Betriebene Beschickungsvorrichtungen für Herdöfen). Oskar Simmersbach. An illustrated review of some American, German and other electric charging apparatus for open-hearth furnaces. 2500 w. Stahl u Eisen—July 15, 1903. No. 56284 D.

Comparative Costs.

The Cost of Production of Pig Iron in America, Great Britain and Germany (Die Gestehungskosten des Amerikanischen Roheisens im Vergleich zu Grossbritannien und Deutschland). O. Simmersbach. Comparative tables and statistics. 1600 w. Glückauf—May 16, 1903. No. 56-286 D.

Crystallization.

The Dangerous Crystallization of Mild Steel and Wrought Iron. J. O. Arnold. Illustrates a machine for testing vibratory brittleness and reviews various investigations in this field. 1000 w. Ir & Coal Trds Rev—June 26, 1903. No. 56493 A.

Electric Rolling Mill.

See Electrical Engineering, Power Applications.

Frozen Furnaces.

The "Freezing" of Blast-Furnaces and the Remedies Therefor (Das Auftreten von Rohgängen und Ihre Beseitigung). E. Jagsch. An illustrated account of the way the contents of blast furnaces become solidified, partly or wholly, and of the methods for removing the obstructions and restoring normal working. 2500 w. Stahl u Eisen—July 15, 1903. No. 56-282 D.

Lake Superior Co.

The Consolidated Lake Superior Company. Information from President Shields' report on the various productive properties of the Company. 3000 w. Ir Age—July 23, 1903. No. 56774.

Magnetic Concentration.

Progress in Magnetic Concentration of Iron Ore. J. Walter Wells. Discusses concentration, reasons for concentrating iron ores, methods, and the present status of magnetic concentration, describing a few machines in use. 6000 w. Can Min Rev—June 30, 1903. No. 56459 B.

Molybdenite.

Molybdenite and the Commercial Products Derived Therefrom. Dr. J. Ohly. Concerning this mineral, recently applied to the improvement of carbon steel, and the treatment it requires. 1200 w. Min Rept—July 16, 1903. Serial. 1st Part. No. 56780.

Open-Hearth.

The Productions of Open-Hearth Steel from Molten Blast-Furnace Metal. Benjamin Talbot. Read before the Engng. Con. of the Inst. of Civ. Engrs. An out-

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line of the continuous process, with some results obtained. 1100 w. Ir & Coal Trds Rev—June 26, 1903. No. 56491 A.

Ore Testing.

The Evolution of the Determination of Iron in Ores. Harrison W. Craver. A review of methods used from the earliest times to those now in common use. 3000 w. Pro Engrs Soc of W Penn—May, 1903. No. 56859 D.

Pig Iron.

Machine Cast Sandless Pig Iron. Edgar S. Cook. Read before Am. Soc. for Test. Materials. Its relation to the standardizing of pig iron for foundry purposes is discussed, and its advantages stated. 5200 w. Ir Age—July 9, 1903. No. 56538.

Railway Iron.

Iron in Railway Service (Das Eisen in der Eisenbahn nach Beschaffenheit, Form und Masse). Dr. A. Haarmann. A paper before the International Congress of Applied Chemistry, giving a general review of iron and steel in their relation to railways, of iron and steel rails and of the growth of railways. 6000 w. Stahl u Eisen—June 15, 1903. No. 56274 D.

Regenerative Valves.

New Valves for Regenerative Furnaces. Illustrates and describes the Czekalla system, and the Naegel system, both of which close the valves at one end of the furnace before those at the other end are opened. 1800 w. Ir Age—July 23, 1903. No. 56776.

Reversing Apparatus for Siemens-Martin Furnaces (Umsteuerungsvorrichtung für Siemens-Martinöfen). Josef Czekalla. An illustrated description of apparatus for reversing the flow of gases and air in regenerative furnaces, without losing any gas. 1600 w. Stahl u Eisen—June 15, 1903. No. 56276 D.

Rolling.

The Determination of Power for Rolling Iron and Steel. Louis Katona. A discussion intended to give light on questions bearing upon this subject. 4000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 56767 C.

Sauveur Method.

Pipeless Ingots by the Sauveur Overflow Method. Albert Sauveur and Jasper Whiting. Read at meeting of Am. Soc. for Test. Materials. Brief illustrated description of a method believed to be practical for the casting of pipeless ingots. 2000 w. Ir Trd Rev—July 9, 1903. No. 56619.

Specifications.

The Steel Manufacturers' Standard Specifications. Albert Ladd Colby. Abstract of a paper read before the Am. Soc. for Test. Materials. Information in regard to the revised "manufacturers' standard specifications" and their requirements. 1600 w. Eng Rec—July 18, 1903. No. 56735.

See also Civil Engineering, Bridges.

Swedish Iron.

The Swedish Lancashire Iron. Birger F. Burman. Discusses points in the manufacture of this iron which is often called "the best iron in the world." 2700 w. Ir Age—July 16, 1903. No. 56685.

Utah.

The Utah Iron Fields. An account of these deposits, and the plans for mining and manufacturing. 2800 w. Ir Age—July 16, 1903. No. 56684.

Vermilion Range.

Test Drilling on the Vermilion Iron Range. Kirby Thomas. Describes the methods of test drilling adopted. Ill 1700 w. Eng & Min Jour—June 27, 1903. No. 56440.

MINING.

Ankylostomiasis.

Ankylostomiasis and Measures Taken to Combat It (Die Wurmkrankheit und die zu Ihrer Bekämpfung Getroffenen Massnahmen). Dr. Weidtman. A paper before a Dortmund mining society, giving a description of this worm disease, which is prevalent among German miners, and of the measures taken to prevent it and stamp it out. 5500 w. Glückauf—June 6, 1903. No. 56290 D.

Ankylostomiasis in the Coal Mines of the Liége District, Belgium (Die Wurmkrankheit in den Kohlenbergwerken des Lütticher Reviers). Dr. Löbker, Hrn. Bingel, Lüthgen and G. A. Meyer. A report of a German commission sent to investigate the worm disease among the Belgian coal miners. 3000 w. Glückauf—June 27, 1903. No. 56295 D.

Arid Regions.

Mining Camps in an Arid Region. Prof. Arthur Lakes. Calls attention to things that are absolute necessities if they are to be prosperous. 2000 w. Mines & Min—July, 1903. No. 56375 C.

Coal-Cutting Machines.

See Mining and Metallurgy, Coal and Coke.

Core Drilling.

Core Drilling Without Diamonds. An illustrated description of core drilling by the steel-shot process. 800 w. Sci Am—July 18, 1903. No. 56676.

Development.

Mine Development Methods. B. J. Forrest. Notes on prospecting, proving and testing deposits, developing, transport, etc. 1400 w. Can Min Rev—June 30, 1903. No. 56457 B.

The Payment of Extensions of Mining Plant Out of Revenue. Discusses the suitability of the ordinary methods of accounting to the case of mining. 1600 w. Eng & Min Jour—July 11, 1903. No. 56629.

Electric Machinery.

See Electrical Engineering, Power Applications.

English School.

The History of the English School of Mines. Outlines the history of the Royal School of Mines, giving illustration of the building. Also editorial on the recent announcement that it was to become a part of the technical college at South Kensington, and protesting against such action. 1800 w. Eng & Min Jour—July 25, 1903. No. 56838.

Freezing Process.

Sinking a Shaft of a Coal Mine, at Eygelshoven, Holland, by the Freezing Process (Das Abteufen des Schachtes I der Bergwerkgesellschaft Laura und Vereenigung zu Eygelshoven, Holländisch Limburg, mittels Gefrierverfahrens). R. Pierre. An illustrated description of the sinking of a shaft through 300 feet of watery sand. 2 Plates. 3500 w. Glückauf—May 23, 1903. No. 56288 D.

Miner's Phthisis.

Miner's Phthisis. William Cullen. Reply to discussion on writer's paper on this subject. 2700 w. Jour Chem & Met Soc of S Africa—May, 1903. No. 56574 E.

Mining Machinery.

Compressed Air and Electricity in Mining Operations. W. L. Saunders. A discussion of the paper of W. B. Clarke, on "Electrical Apparatus for Coal-Mining." 5000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 56760.

Early History of Mining Machines in Great Britain. C. M. Percy. Describes some of the first machines and explains reasons why they did not succeed. 2800 w. Mines & Min—July, 1903. No. 56376 C.

Mining with Machine Drills. E. L. LeFevre. Discusses air power as a factor in economic mining. 2000 w. Min & Sci Pr—July 11, 1903. Serial. 1st Part. No. 56727.

See also Electrical Engineering, Power Applications; and Mining and Metallurgy, Coal and Coke.

Rope Haulage.

Penwyllt Haulage. A statement of the conditions to be met at the Penwyllt Dinas Silica Brick-Works, Wales, with an illustrated description of the special system of endless rope haulage adopted on account of its low initial cost and its economy in working. 1100 w. Col Guard—June 19, 1903. No. 56332 A.

Safety Appliance.

Safety Appliance for Working Steep Seams. From *Zeitschrift für Berg-, Hütten-, und Salinenwesen.* Brief illustrated description of arrangements used at Polnisch-Ostrau. 300 w. Col Guard—July 3, 1903. No. 56576 A.

Smokeless Powders.

Smokeless Powders: Their History and Present Classification. Brief review of different stages in its development, with present classification. 2000 w. Sci Am Sup—July 25, 1903. No. 56796.

Stamps.

Direct Steam Ore Stamps. Charles H. Fitch. Describes some of these stamps calling attention to some of their disadvantages. 1700 w. Min & Sci Pr—July 11, 1903. No. 56726.

MISCELLANY.

Alloys.

Alloying by Means of Metallic Salts. Walter J. May. Some points from the writer's experience showing the process is of some importance in practical working. 1000 w. Prac Engr—June 26, 1903 No. 56475 A.

See also Mechanical Engineering, Materials of Construction.

Alluvial Deposits.

Measurements Relating to Alluvial Deposits. Ralph L. Montagu. Illustrates a drill-hole computer, explaining its use. 1000 w. Min & Sci Pr—June 27, 1903. No. 56519.

Analysis.

A System of Qualitative Analysis Including Nearly All the Metallic Elements. Arthur A. Noyes. The aim of this investigation is to work out in detail a universally applicable scheme which shall include as nearly as practicable all the metallic elements, and make possible their detection even when present in quantity as small as one or two milligrams. 1600 w. Tech Quar—June, 1903. Serial. 1st Part. No. 56388 E.

British Columbia.

Mining in British Columbia. Information from the official report of the minister of mines, in regard to production, value, etc. 500 w. U S Cons Repts, No. 1686—July 1, 1903. No. 56348 D.

Diamonds.

The Mining of Diamonds. A brief account of mining in South Africa. 1200 w. Min & Sci Pr—June 27, 1903. No. 56520.

Do Diamonds Occur in German Southwest Africa? (Kommen in Deutsch-Südwestafrika Diamanten Vor?) Hr. Mentzel. A comparison of analyses of minerals from Gibeon, in German South-

We supply copies of these articles. See page 958.

west Africa, and from Kimberley, showing the similarity, and a discussion of the probability of diamonds occurring at the former place. 1200 w. Glückauf—June 13, 1903. No. 56291 D.

Dust Analysis.

A New Process for the Quantitative Determination of Dust in Gases (Ein Neues Verfahren zur Quantitativen Bestimmung von Staub in Gasen). Leo Martius. An illustrated description of apparatus and methods for analyzing dust, particularly that in blast-furnace gases. 1400 w. Stahl u Eisen—June 15, 1903. No. 56275 D.

Fire Brick.

Fire-Resisting Masonry in Iron and Steel Manufacture (Einwirkung Zerstörender Einflüsse auf Feuerfestes Mauerwerk im Hüttenbetriebe). Bernhard Osann. A general discussion of firebrick and other fire-resisting masonry, and the causes which tend to injure them. 4000 w. Stahl u Eisen—July 15, 1903. No. 56283 D.

Frank Disaster.

The Turtle Mountain Rock Slide. Walton E. Dowlen. An illustrated description of the conditions which give an explanation of this disaster in Alberta, Canada. 2000 w. Eng & Min Jour—July 4, 1903. No. 56526.

Furnaces.

An Experimental Reverberatory Furnace. Woolsey McA. Johnson. An illustrated detailed description of two small furnaces for the study of ordinary metallurgical processes. 1400 w. Eng & Min Jour—July 18, 1903. No. 56729.

On Adobe and Other Makeshift Furnaces. Henry F. Collins. Abstracted from the Proceedings of the Institute of Mining and Metallurgy, London. Describes primitive appliances used for temporary work, often useful to meet special conditions. Ill. 3500 w. Eng & Min Jour—July 11, 1903. Serial. 1st Part. No. 56630.

Geology.

Geologizing by the Seaside. Prof. Arthur Lakes. Illustrations of geological phenomena related to mining, as shown in the sea cliffs and caves at La Jolla, near San Diego, Cal. 3300 w. Mines & Min—July, 1903. No. 56374 C.

German Colonies.

Mineral Products of the German Protectorates (Die Gewinnung Mineralischer Bodenschätze in den Deutschen Schutzgebieten). Hr. Macco. A review, founded on government reports, of the mineral industry of the German possessions in Africa and the Pacific. 1500 w. Glückauf—May 30, 1903. No. 56289 D.

Hot Springs.

Hot Springs. Edouard Suess. A study of the phenomena of hot springs. Translated from the German. 2800 w. Eng & Min Jour—July 4, 1903. Serial. 1st Part. No. 56525.

Lead.

The Chemical and Fire Methods of Determining Lead in Ores. R. F. McElvenny and G. A. Izett. Discusses various wet methods, aiming to determine their efficiency and defects, and to find one applicable to present needs. 1800 w. Min Rept—July 2, 1903. Serial. 1st Part. No. 56501.

The Commercial Assay of Lead Ores. A. W. Warwick. Read at meeting of the Colorado Sci. Soc. Also discussion. Briefly considers the fire assay, which the writer considers inaccurate; and the volumetric method, which he considers sufficiently accurate for all commercial purposes. 2200 w. Min Rept—July 9, 1903. No. 56609.

The Refining of Lead Bullion. F. L. Piddington. An account of the Parkes' process of desilverizing and refining lead bullion, as carried out at the works of the Smelting Co. of Australia. 2400 w. Jour Chem & Met Soc of S Africa—May, 1903. No. 56573 E.

Legislation.

Historical Sketch of Mining Legislation in Mexico. Eduardo Martinez Baca. 18000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 56769 D.

Minnesota.

The Geology of Minnesota. Prof. C. W. Hall. Address before the International Min. Cong. A description of the various formations in the state, and an account of their products which are of economic value. 4500 w. Mines & Min—July, 1903. No. 56371 C.

Nickel.

Nickel Deposits in New Caledonia. Major R. G. Leckie. Information in regard to the deposits found on this island of the Southern Pacific, analysis, methods of mining, and related matters. 2000 w. Can Min Rev—June 30, 1903. No. 56458 B.

Nickel Steel.

See Mechanical Engineering, Materials of Construction.

Opal-Mining.

The Queensland Opal Mining Industry. C. F. V. Jackson. Report for 1902. The conditions were unfavorable owing to the failure of the rainfall for the sixth year in succession. Gives information of the principal districts, and thinks the future prospects encouraging. 2600 w. Queens Gov Min Jour—May 15, 1903. No. 56380 B.

We supply copies of these articles. See page 958.

Petroleum.

The Barboursville Oil-Field, Kentucky. S. W. McCallie. An illustrated description of this field in the southeastern corner of Kentucky, and information regarding it. 1200 w. Eng & Min Jour—July 4, 1903. No. 56527.

Pyrometer.

See Electrical Engineering, Measurement.

Sudbury, Ont.

The Ore Deposits of Sudbury, Ontario. Charles W. Dickson. This district is one of the two great sources of nickel. Considers the relation of nickel to pyrrhotite, and the genesis of the ores. Ill. 21500 w. Trans Am Inst of Min Engrs —Feb., 1903. No. 56758 D.

Zinc.

Notes and Data of Interest to Zinc Miners. W. George Waring. Discusses the valuation of zinc ores, the specific gravity and composition of zinc minerals, and assay results as a guide in ore-dressing. 1500 w. Eng & Min Jour—July 4, 1903. No. 56529.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accident.

The Leven Viaduct Accident. An account of a railway accident in which a train was blown bodily over on its side, giving anemometer records made during the night of the accident. 900 w. Engr, Lond—July 3, 1903. No. 56588 A.

Accident Service.

Prompt Aid in Railway Accidents (Des Prompts Secours dans les Accidents de Chemins de Fer). P. Redard. An illustrated description of hospital cars and accident service maintained by some Continental railways. 3000 w. Génie Civil—June 6, 1903. No. 56910 D.

Discipline.

Notes on Discipline. A. J. Love. On the importance of discipline in railroad work, the force of correct habits, and related subjects. 1500 w. R R Gaz—July 17, 1903. No. 56755.

Fast Runs.

A Royal Train "Record." Brief account of a run made by the Royal train on the Great Western Railway, from London to Cornwall. 600 w. Engr, Lond—July 17, 1903. No. 56815 A.

A "Record" Run on the London and South-Western. Charles Rous-Marten. An interesting account of the inaugural trip of fast service on the road named. 3300 w. Engr, Lond—July 10, 1903. No. 56694 A.

Great Northern Records Between London and Leeds. Charles Rous-Marten. A report of two record trips on this British railway. 2000 w. Engr, Lond—July 17, 1903. No. 56813 A.

High Speeds on Railways. James Charles Inglis. Read at the Engng. Con. of the Inst. of Civ. Engrs., England. Considers the design of permanent way and locomotives for high speed. 1500 w. Engng—June 19, 1903. No. 56314 A.

MOTIVE POWER AND EQUIPMENT.

Adhesion Increasers.

Arrangements for Temporarily Increasing the Adhesion of the Driving Wheel of Locomotives (Vorrichtungen zur Zeitweiligen Erhöhung des Triebraddruckes bei Lokomotiven). Prof. K. Keller. Illustrated descriptions of various methods of increasing the portion of the weight of locomotives resting on the drivers at starting. 5000 w. Zeitschr d Ver Deutscher Ing—June 20, 1903. No. 56230 D.

Brakes.

Foundation Brake Rigging. Henry Kolsath. Read at meeting of the New England R. R. Club. Discusses the design and construction of foundation brake gear in detail. 2800 w. R R Gaz—July 24, 1903. No. 56848.

Car Capacity.

The Increase in Capacity of Open Freight Cars on the Prussian State Railways (Ueber die Erhöhung der Ladefähigkeit der Offenen Güterwagen bei den Preussischen Staatsbahnen). Hr. von Schwabe. A discussion of the question of increasing the capacity of cars, and figures showing the relations between live and dead loads on German and American railways. 2000 w. Glasers Annalen—July 1, 1903. No. 56244 D.

Car Heating.

See Mechanical Engineering, Steam Engineering.

Cars.

Progress in Car Building. Editorial review of recent improvements and designs, the troublesome details, types, etc. 2000 w. R R Gaz—June 26, 1903. No. 56456.

Long Passenger Cars for the Monon. Plans, elevation and description of a combination passenger and baggage car with steel under frame; and a ladies' coach, 70 ft. 8 in. in length, seating 88 persons. 450 w. R R Gaz—June 26, 1903. No. 56451.

We supply copies of these articles. See page 958.

New Coaches on the Central London Railway. Illustration with brief description of new motor coach adopted to lessen the vibration. 600 w. Engr, Lond—July 3, 1903. No. 56587 A.

Draft Connections.

Drawbar and Buffer Attachments for Use Between Engine and Tender. Henry Bartlett. Read at convention of Am. Ry. Mas. Mechs. Assn. A discussion of the best arrangement, the form and relative strength of the drawbar to tractive power of the engine, etc. Ill. 2800 w. Ry Age —June 27, 1903. (Daily Ed.) No. 56513.

Dust Guard.

The Symington Dust Guard. An illustrated detailed description. 1000 w. R R Gaz—June 26, 1903. No. 56453.

Injectors.

Injectors as They Are Met With in Every Day Railway Practice. F. W. Edwards. Introductory to a general discussion. Considers the mounting of injectors, location on different classes of boilers, care, failures, etc. 11000 w. Pro W Ry Club—May 19, 1903. No. 56352 C.

Internal-Combustion Engines.

Internal Combustion Engine in Railway Service. Abstract of a paper by R. P. C. Sanderson before the Mas. Mechs.' Assn. Thinks these engines will soon invade the field now occupied by steam locomotives. 1300 w. Ry & Engng Rev —June 27, 1903. No. 56460.

Locomotives.

British and Continental Locomotive Types. Charles S. Lake. Brief discussion of various types of engines employed in dealing with specified classes of traffic. Ill. 1800 w. Prac Engr—June 19, 1903. Serial. 1st Part. No. 56307 A.

Atlantic Type Engine in Germany. Illustrated description of a German four-cylinder Atlantic type compound. 450 w. Loc Engng—July, 1903. No. 56411 C.

Consolidation Locomotive for Southern Railway. Illustrated description of simple cylinder balanced slide valve engines. 700 w. Ry & Engng Rev—July 4, 1903. No. 56523.

Fast Freight Engines for the Lackawanna. Illustrated description of medium size mogul locomotives, for hauling fast freight; some for the use of soft coal, and others for anthracite, the only difference being in the fireboxes. 700 w. Ry Age—June 26, 1903. No. 56369.

Narrow-Gauge Tank Locomotive for the Bengal-Nagpur Railway. Two-page plate and other illustrations of an exceptionally powerful narrow-gauge engine. 600 w. Engng—July 3, 1903. No. 56578 A.

Ten-Wheel Compound Locomotive for the Chicago & Eastern Illinois. Illustrated detailed description of engines for heavy passenger or fast freight service. 500 w. Ry Age—July 10, 1903. No. 56648.

Two Large Express Passenger Locomotives. Illustrations, with brief descriptions of engines for use on the Caledonian and North-Eastern Railways. 500 w. Mech Engr—June 27, 1903. No. 56472 A.

See also Mechanical Engineering, Miscellany.

Motor Cars.

Automobile Cars and Locomotives for Railways (Gleis-Motorwagen und Gleis-Motorlokomotiven). Julius Küster. Illustrated description of automobiles for hauling cars or for carrying loads themselves, adapted to run on tracks. 1 Plate. 3000 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 9, 1903. No. 56226 D.

Light Motors on Local Railways (Einführung Leichter Motoren beim Betriebe auf Lokalbahnen). Illustrated description of steam motor cars, built by F. X. Komarek, to replace locomotives on some Austrian railways. 1 Plate. 1000 w. Mitt de Ver f d Förderung d Lokal u Strassenbahnwesens—April, 1903. No. 56193 D.

Purrey Steam Motor Cars on French Railways (Voitures Automotrices à Vapeur, Système V. Purrey). J. Tête. Illustrated descriptions of passenger cars with steam motors, one on the Paris-Lyons-Mediterranean, and another on the Orleans Railway, with results of operation. 2 Plates. 4000 w. Rev Gén Chemins d Fer—July, 1903. No. 56942 H.

Steel Cars.

Steel Cars Without Center Sills. E. W. Summers. Suggests changes that might be advantageously made in steel cars, especially discussing the doing away with the center sill. General discussion. Ill. 13400 w. Pro Ry Club of Pittsburg —March, 1903. No. 56353 C.

Modern Steel Cars. Illustrations, and brief descriptions of recent designs. 1200 w. R R Gaz—June 26, 1903. No. 56454.

Train Lighting.

See Electrical Engineering, Lighting.

Train Resistance.

Frictional Resistances on Railways (Der Reibungs-Widerstand bei Schienenbahnen). A discussion of the various resistances met with by trains moving on rails, with formulas and diagrams. Serial. 2 Parts. 9000 w. Ill Zeitschr f Klein u Strassenbahnen—June 1 and 16, 1903. No. 56190 each C.

German Tests of Railway Train Resistance. Prof. Albert Frank, in the *Zeitschrift des Vereins Deutscher Ingenieure.*

We supply copies of these articles. See page 958.

A report of a series of tests at different speeds carried out on the state railways of the kingdom of Hanover, Germany. 1000 w. Eng News—June 25, 1903. No. 56361.

Weed-Burning.

New Weed-Burning Cars, C. M. & St. P. Ry. Illustrated description of one of the new machines for this purpose, with an account of its working. 1500. Ry & Engng Rev—June 27, 1903. No. 56461.

Wheels.

See Mechanical Engineering, Machine Works and Foundries.

NEW PROJECTS.

Anatolia.

Construction Work on the Anatolian Railway, Turkey (Von der Anatolischen Eisenbahn). Hr. Denicke. An illustrated description of tunnel repair work on this road in Asiatic Turkey. 1400 w. Zentralblatt d Bauverwaltung—April 4, 1903. No. 56208 B.

Austria.

New Railway Construction in Austria (Die Eisenbahnenbauten in Oesterreich). A description, with map and profiles, of new railways under construction in different parts of Austria. Serial. Part 1. 1200 w. Zentralblatt d Bauverwaltung—July 11, 1903. No. 56219 B.

China.

The Shan Tung Railway (Ueber die Shantung Eisenbahn). A. Gaedertz. An address before the Verein für Eisenbahnkunde, giving an account of the railway being built by the Germans in the northeastern part of China. Profile. 5000 w. Glasers Ann—July 1, 1903. No. 56242 D.

Ireland.

The Letterkenny and Burton Port Railway. An illustrated account of railway work in the west of Ireland, particularly the Burton Port extension, a government subsidized light railway. 3000 w. Transport—July 3, 1903. No. 56560 A.

Manchuria.

The Chinese Eastern (Manchurian) Railway. Alfred Stead. An illustrated description of the Manchurian railway based upon notes personally made during a tour of inspection. 2300 w. Page's Mag—July, 1903. No. 56594 B.

PERMANENT WAY AND BUILDINGS.

Gauge.

The Choice of Gauge on Secondary Railways (Die Wahl der Spurweite bei Lokalbahnen). E. A. Ziffer. An address containing a general discussion of the best gauge for tracks under various circumstances. 4500 w. Mitt d Ver f d Förderung d Lokal u Strassenbahnwesens—June, 1903. No. 56194 D.

Norfolk & Western.

The Norfolk & Western Railroad. George L. Fowler. The present physical condition and its operation is discussed in the present article. 3000 w. Ill. R R Gaz—July 3, 1903. Serial. 1st Part. No. 56552.

Rails.

Tests of Unit Fiber Strains in the Base of Rails. P. H. Dudley. Presented before the Am. Soc. for Test. Materials. Gives tabulated stremmatograph tests, and an interesting discussion of track construction and related subjects. 5000 w. Ry Age—July 24, 1903. No. 56827.

Results Observed Upon the Philadelphia & Reading Ry. in Connection with Inspection of Steel Rails. Robert Job. Presented at meeting of the Am. Soc. for Test. Materials in discussion of report on Specifications for Steel Rails. Ill. 1000 w. Eng News—July 16, 1903. No. 56751.

Shops.

Milwaukee Shop Improvements of the Chicago, Milwaukee & St. Paul. An illustrated description of the modernization and enlargement of this important plant, with rearrangement and extensive increase of yard tracks. 3500 w. R R Gaz—June 26, 1903. No. 56450.

The New Shops of the American Locomotive Company at Schenectady. Lindsay Duncan. Illustrates and describes the design and construction of important additions to the plant at Schenectady, the transportation arrangements, power distribution, etc. 3500 w. Eng Rec—June 27, 1903. No. 56449.

Signalling.

Automatic Signalling. William John Cudworth. Read at the Engng. Con. of the Inst. of Civ. Engrs. Discusses the various systems of automatic working that have been tried. Ill. 1000 w. Engng—June, 1903. No. 56317 A.

Automatic Signal-Protection for Milwaukee Passenger Station, Chicago, Milwaukee and St. Paul Railway. An illustrated description of a recently installed system to protect the five tracks under the train-shed of the passenger station. 2000 w. Ry Age—July 3, 1903. No. 56516.

Normal Clear vs. Normal Danger Automatic Block Signal Systems. Discusses the merits of the two systems, and suggests that enginemen be required to observe the signal operate. 1800 w. Ry Age—July 17, 1903. No. 56782.

The "Crewe" System of Electrically-Operated Points and Signals. Illustrated detailed description. 3200 w. Engng—July 17, 1903. No. 56820 A.

The Distant Signal. H. Raynar Wilson. A letter explaining British practice,

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and points of difference from American practice. 2300 w. R R Gaz—July 24, 1903. No. 56847.

The Evolution of Railroad Signaling. Charles Hansel. Historical review, with statement of the writer's views on the best practice. Editorial note. 4000 w. R R Gaz—July 10, 1903. No. 56649.

The Taylor Electric Signal System at the Railway Station of Pétange, Luxemburg (Note sur les Postes Electriques, Système Taylor, de la Gare de Pétange, Grand Duché de Luxembourg). M. Collot. Illustrated description of an interlocking switch and signal system at an important railway junction. 1 Plate. 1800 w. Rev Gén Chemins d Fer—June, 1903. No. 56940 H.

Ties.

The Cutting and Laying of Ties. Herman von Schrenk. The importance of laying the tie so that the convex side of the annular rings is on the upper side. Ill. 600 w. R R Gaz—July 17, 1903. No. 56756.

The Seasoning of Tie Timber. Herman von Schrenk. From the Bureau of Forestry Bulletin, No. 41. On the treatment and processes of preservation, etc. 2800 w. R R Gaz—July 3, 1903. Serial. 1st part. No. 56550.

Turntable.

See Electrical Engineering, Power Applications.

Winter Construction.

Methods for Winter Railway Location and Construction. E. H. Drury. Descriptive notes of methods used in locating and building railways in mid-winter in a northern bush country, where the thermometer is sometimes 40 degrees below zero. 2000 w. Eng Rec—July 4, 1903. No. 56544.

TRAFFIC.

Tonnage.

Effects of Tonnage Ratings on the Cost of Transportation. C. H. Quereau. Read before the Mas. Mechs.' Assn. Showing savings and benefits due to the use of tonnage ratings. 3000 w. Ry & Engng Rev—June 27, 1903. No. 56462.

MISCELLANY.

Brushes.

Brush Specifications, Long Island Railroad. A copy of these novel specifications. Ill. 1200 w. R R Gaz—June 26, 1903. No. 56455.

Government Ownership.

Government Ownership of Railways. H. R. Meyer. The first of a series of articles aiming to give the facts regarding the experience of Europe and Australasia in the adjustment of railway rates and management of the railways. 4000 w. Ry Age—July 10, 1903. Serial. 1st Part. No. 56647.

Legislation.

Railroad Legislation in Connecticut. Clarence Deming. An outline of the present situation in the Connecticut legislature in regard to electric and steam railroads. 1800 w. R R Gaz—June 26, 1903. No. 56452.

Standards.

Correct Railroad Standards. W. H. Sheasby. Prize paper, read before the Pacific Coast Ry. Club. A criticism of some railroad practices and methods. 4000 w. Ry Age—July 3, 1903. No. 56515.

STREET AND ELECTRIC RAILWAYS

Accumulator Traction.

The Application of Accumulators in Transportation (Die Verwendung des Akkumulators in der Verkehrstechnik). Dr. Max Büttner. A paper before the Verein Deutscher Maschinen-Ingenieure, giving an illustrated account of the use of storage batteries in power stations, and on cars, locomotives, cranes, automobiles, etc. 10000 w. Glasers Annalen—June 15, 1903. No. 56241 D.

See also Electrical Engineering, Generating Stations.

Berlin.

Local Passenger Traffic in Berlin (Der Berliner Lokalverkehr). A general discussion of the local transportation problem in Berlin, and of existing and projected means of travel. 2500 w. Ill Zeitschr f Klein u Strassenbahnen—July 1, 1903. No. 56192 C.

Brakes.

Power Brakes in St. Louis. R. P. Garrett. Explains the conditions in St. Louis which led to the requiring all street cars to be equipped with power brakes, and illustrates two of the makes approved by the Board of Public Improvements. 900 w. R R Gaz—July 24, 1903. No. 56849.

An Emergency Track Brake Used by the United Railroads of San Francisco. Describes the conditions in San Francisco which made necessary a brake that would stop cars on heavy grades, and gives an illustrated description of the brake designed by G. W. Douglas, now

in successful use. 1300 w. St Ry Jour—July 4, 1903. No. 56532 D.

British Railways.

The Electrification of British Railways. Reviews briefly what has been accomplished on the continent of Europe, and discusses the peculiar features of the problem in Great Britain. Maps. 5800 w. St Ry Jour—July 4, 1903. No. 56531 D.

Brooklyn.

The New Third Avenue Station of the Brooklyn Rapid Transit Co. Arthur L. Rice. An illustrated detailed description of the building construction of this new station and its equipment. 3000 w. Engr, U S A—July 15, 1903. No. 56740 C.

Car Seating.

The Suburban Car Seating Problem. Describes the four plans of seat arrangement being considered by the Illinois Central R. R. 900 w. Loc Engng—July, 1903. No. 56412 C.

Census.

The Census Report on the Street Railway Industry. Reviews this report, giving details of interesting statistics. 1800 w. St Ry Jour—July 11, 1903. No. 56626 D.

Chicago.

Proposed Inner Circle System for Chicago. Illustrated description of a plan by A. S. Robinson, which consists of one inner circle or loop subway, upon which cars will move only in one direction, acting as a transfer and stopping at all stations. 1200 w. St Ry Jour—July 11, 1903. No. 56625 D.

Cleveland Interurban.

Improvements on the Cleveland & Southwestern Interurban System. An illustrated article reviewing this system and describing recent construction and equipment. 3000 w. St Ry Jour—June 27, 1903. No. 56436 D.

Comparison.

Comparative Cost and Advantages of the Underground Conduit and the Overhead Trolley Systems. A report by Messrs. Maurice Fitzmaurice and Alfred Baker, presented to the London County Council. 3300 w. Tram & Ry Wld—June 11, 1903. No. 56344 B.

Electric Locomotives.

Electric Mining Locomotives and Auxiliary Machinery. Frank C. Perkins. States the special advantages of their use for haulage and gives information of types used in various mines. 1000 w. Min Rept—July 16, 1903. Serial. 1st Part. No. 56778.

Electro-Pneumatic.

A Single-Phase Electric Railway with Pneumatic Acceleration (Einphasenbahn mit Pneumatischer Beschleunigung). W. A. Blanck. An illustrated brief description of the B. J. Arnold system of single-phase electric and compressed-air traction. 1000 w. Elektrotech Zeitschr—July 16, 1903. No. 56261 B.

Elevated Railways.

Elevated Railways. Gerald Barker. Considers some of the advantages claimed for the deep-level tube railways, the railways in shallow subways, the tramways on the surface, and elevated railways. Also considers the disadvantages that have been alleged against these systems. Ill. 3300 w. Engng—July 24, 1903. No. 57024 A.

Energy Losses.

Energy Losses on Electric Cars. W. Park. Gives diagrams showing the distribution of the losses on an electric car, and suggests ways of effecting increased running efficiency. 1400 w. Tram & Ry Wld—June 11, 1903. No. 56343 B.

England.

English Interurban Line. Illustrates and describes an interesting electric railway, recently completed, extending from the outskirts of Portsmouth to Horndean. 2200 w. St Ry Jour—June 27, 1903. No. 56427 D.

European Tramways.

Notes on European Tramways. Richard McCulloch. General observations of an engineer engaged in the examination, construction, and operation of tramways, traveling with the view of locating tramway lines. Ill. 8500 w. W Soc of Engrs—June, 1903. No. 56398 D.

Feeder Problems.

Notes on Railway Feeder Problems. William A. DelMar. Treats only of direct-current feeders which supply current to the cars. 2500 w. Am Elect'n—July, 1903. No. 56638.

Fender.

The Kliemann Fender for Street Cars and Automobiles (Die Kliemannsche Schutzvorrichtung für Strassenbahnwagen und Motorfahrzeuge). An illustrated description of a network fender with two pockets, on a frame of iron covered with rubber tubing. 2500 w. Ill Zeitsch f Klein u Strassenbahnen—May 1, 1903. No. 56189 C.

Germany.

Statistics of Electric Railways in Germany, Oct. 1, 1902 (Statistik der Elektrischen Bahnen in Deutschland nach dem Stande vom 1. Oktober, 1902). General statistics of all German electric railways, in operation or under construction, with editorial. Tables. 10000 w. Elektrotech Zeitschr—July 9, 1903. No. 56256 B.

We supply copies of these articles. See page 958.

Glasgow.

The Glasgow Municipal Tramway System. Historical descriptive account of this very successful undertaking, with illustrations and maps. 4500 w. Tram & Ry Wld—July 9, 1903. No. 56690 B.

Hartford.

Hartford Street Railway Co. An illustrated article describing additional power generating facilities and new car house at Hartford, Conn. 4800 w. St Ry Rev—July 20, 1903. No. 56781 C.

High-Speed.

I. High-Speed Electric Traction on Railways. J. W. Jacomb-Hood. II. The Position and Protection of the Third-Rail on Electric Railways. William E. Langdon. Two papers read at the Engng. Con. of the Inst. of Civ. Engrs. and discussed together. 4800 w. Elect'n, Lond—July 3, 1903. No. 56570 A.

Holiday Traffic.

Holiday Traffic on Tramways. L. E. Harvey. Discussing the question of how far it pays to keep extra cars especially for holiday and week-end traffic in England. 1200 w. Elec Rev, Lond—July 10, 1903. No. 56716 A.

Incline Railway.

Mount Beacon Incline Railway. Illustration, with brief description of a recently built railway up the steep face of one of the Fishkill mountains, near Matteawan, N. Y. 1000 w. Sci Am Sup—July 25, 1903. No. 56797.

Milford, Mass.

Milford Street Railway System. An illustrated description of a road interesting on account of the peculiar situation in reference to the territory covered and the steam roads in that section. 1500 w. St Ry Jour—July 25, 1903. No. 56832 D.

Motors.

Electric Railway Motors (Der Elektromotor als Eisenbahnmotor). Dr. F. Niethammer. A classification and review of the different systems of electric traction and a discussion comparing the direct-current motor very favorably with the polyphase motor. Serial. 2 Parts. 6000 w. Zeitschr f Elektrotech—June 14 and 21, 1903. No. 56262 each D.

Ventilating Railway Motors. Illustrates and describes a plan for ventilating and cleaning railway motors while in operation in regular commercial service. Natural draft is used. Reports tests. 1000 w. St Ry Jour—July 25, 1903. No. 56833 D.

See also Electrical Engineering, Power Applications.

Mountain Railway.

An Electric Mountain Railway in Southern California. An illustrated description of the interesting railway from Los Angeles to the summit of Mount Lowe. 1200 w. Tram & Ry Wld—June 11, 1903. No. 56341 B.

New York.

The Transportation Problem in New York City. Charles Prelini. Considers the difficulties arising from the peculiar configuration of Manhattan Island; the defective plan originally outlined for the city; the great masses that have to be simultaneously handled during the rush hours; and the extraordinary increase in the population. 2800 w. Trac & Trans—July, 1903. No. 56723 E.

Open Car.

Open Elevated Motor Car—Brooklyn Heights Railroad. An illustrated detailed description. 600 w. R R Gaz—July 3, 1903. No. 56551.

Paris Metropolitan.

A General Study of the Metropolitan Railway of Paris (Etude Générale sur le Chemin de Fer Métropolitain de Paris). E. de Loyselles and L. Perreau. A long historical and descriptive review. Serial. Part I. 1000 w. Rev Technique—May 25, 1903. No. 56922 D.

The Paris Metropolitan Railway. A summary of the work, with a description of the principal features of the viaduct is given in the present article. Ill. 3500 w. Engr, Lond—July 10, 1903. Serial. 1st part. No. 56697 A.

The Paris Metropolitan Electric Railway. Daniel Bellet. An illustrated detailed description of the construction work, the difficulties met, etc., with report of the success of the portion of the road in operation. 5600 w. Trac & Trans—July, 1903. No. 56725 E.

Power Stations.

See Electrical Engineering, Generating Stations.

Safety Device.

Electric Train Safety Device. E. C. Parham. Illustrates and describes an automatic device that will not only interrupt the motive power in case of accident, but will also apply the brake. 1400 w. Am Elect'n—July, 1903. No. 56636.

Sault Ste. Marie.

Transportation Facilities at the Soo. An illustrated description of the street railway lines both in Michigan and Ontario, at this point. 1600 w. St Ry Jour—July 1903. No. 56530 D.

Shallow Tunnels.

Shallow Tunnel Railways and the Law. W. Valentine Ball. Discusses some of the legal difficulties that promoters of shallow tunnel railways in England would encounter. 2000 w. Trac & Trans—June, 1903. No. 56303 E.

We supply copies of these articles. See page 958.

Single-Phase Motor.

See Electrical Engineering, Power Applications.

Station Indicators.

Station Indicators for Subway, Elevated and Other Railway Systems. Ernest K. Adams. Brief illustrated descriptions of a number of mechanical and electrical station indicators that seem adapted to the uses named. 2000 w. Elec Wld & Engr—July 11, 1903. No. 56639.

Stray Currents.

The Return Circuits of the Hamburg Electric Railways (Rückleitungsnetz der Elektrischen Strassenbahnen in Hamburg). S. Freiherr v. Gaisberg. A paper before the Verband Deutscher Elektrotechniker, giving an account of the measures adopted to prevent the electrolysis of pipes in Hamburg, Germany. Map and diagrams. 2000 w. Elektrotech Zeitschr—June 25, 1903. No. 56248 B.

Surveys for Electrolysis and Their Results. D. H. Maury. Read before the Am. Water Wks. Assn. Also editorial. Practical suggestions for determining and mapping the conditions of stray current flow, for the purpose of studying the corrosion of underground metal structures by electrolytic action. 6000 w. Eng News—July 23, 1903. No. 56842.

Some Recent Effects of Electrolytic Action Upon Underground Mains and Other Metals. A. A. Knudson. Read at a meeting of the Am. Water Wks. Assn. Considers the law governing return currents of single trolley systems, the passing of current through underground mains, the direction of current, etc. Ill. 3000 w. Am Gas Lgt Jour—July 13, 1903. No. 56646.

Sub-Stations.

See Electrical Engineering, Distribution.

Switzerland.

Electric Railway Between Freiburg-Morat and Anet, Switzerland (Chemin de Fer Electrique de Fribourg-Morat-Anet, Suisse). H. Somach. An illustrated description of a third-rail road, supplied with 750-volt direct current from rotary sub-stations. Part of the line was formerly a steam road. 1 Plate. 3000 w. Génie Civil—June 27, 1903. No. 56914 D.

The First Third-Rail in Switzerland. Henri Somach. An illustrated description of the recently constructed third-rail electric railway extending from Fribourg to Morat, near Neuchatel. 1100 w. St Ry Jour—July 25, 1903. No. 56831 D.

Sydney, N. S. W.

The Electric Tramways of Sydney. An illustrated description of the fine system of tramways constructed and maintained by the State of New South Wales. 3000 w. Tram & Ry Wld—July 9, 1903. No. 56689 B.

Texas.

The System of the Northern Texas Traction Company. Map and illustrated description of the interurban line connecting Dallas and Fort Worth, and the local lines of the two places. 6000 w. St Ry Jour—July 18, 1903. No. 56732 D.

Trackless Trolley.

The Trackless Electric Car Line at Grevenbrück, Westphalia (Die Gleitlose Elektrische Bahn bei Grevenbrück in Westf.). Hr. Voiges. An illustrated description of line with double trolley wire and no track. A light electric locomotive hauls two trailers filled with limestone from a quarry to a railway station. 1200 w. Deutsche Bauzeitung—April 18, 1903. No. 56179 D.

Tracks.

Track Construction with Special Reference to Rail Joints. F. H. Davies. Discusses the track construction of the present, gauge, composition of rails, etc., especially jointing of rails and bonds. 3300 w. Elec Engr, Lond—July 10, 1903. No. 56714 A.

Trackways.

See Civil Engineering, Municipal.

Track Welding.

See Electrical Engineering, Miscellany.

United Kingdom.

"Electrical Review" List of Electric Tramways and Railways in the United Kingdom. List and tabulated information. 5500 w. Elec Rev, Lond—June 26, 1903. No. 56481 A.

United States and Canada.

Street and Elevated Railway Mileage, Cars, and Capitalization in the United States and Canada. Table showing the standing for 1902, with remarks. 700 w. St Ry Jour—July 4, 1903. No. 56534 D.

Urban Railways.

The Relative Advantages of Overhead, Deep Level, and Shallow Subway Lines, for the Accommodation of Urban Railway Traffic. S. B. Cottrell. Read before the Engng. Con. of the Inst. of Civ. Engrs. Briefly considers each type. Discussion follows. 2500 w. Engr, Lond—June 26, 1903. No. 56495 A.

Wrexham.

Electric Tramways in Wrexham. An illustrated description of recently completed lines in North Wales, to take the place of horse tramways. 2800 w. Tram & Ry Wld—June 11, 1903. No. 56342 B.

We supply copies of these articles. See page 958.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Engineers' Pocket Book.

Tables and Other Data for Engineers and Business Men. Compiled by Chas. E. Ferris, B. S. Size, 5¾ by 3 in.; pp. 224. Price, 50 cts. Knoxville, Tenn.: University of Tennessee Press.

The primary object of this little book is to bring directly to the attention of men of affairs the value of technical training in schools and colleges, and as a means of reaching the right persons there is here collected a large amount of information useful to engineers and business men, in very compact and convenient form. There are tables of logarithms, areas and circumferences of circles, squares, cubes and reciprocals, iron bars and rods, hydraulics, earthwork, electric wiring, interest, metric conversion, population of cities, and many others. There is information about cement, stonework, machinery, etc., directions for first aid in case of accidents or drowning, and a variety of other useful data. This book is of vest-pocket size and makes a very handy ready-reference work, of value to men of every calling.

Radium.

Radium and Other Radio-Active Substances. By William J. Hammer. Size, 9¼ by 6; pp. viii, 72; illustrations, 41. Price, $1.00. New York. D. Van Nostrand Company.

Almost every day new facts about radio-active substances are being discovered, and new hypotheses of radio-activity advanced, so that even the professional scientist finds it difficult to keep in touch with all the literature accumulating on the subject, while the average layman is apt to be sorely perplexed by what he hears about the many different kinds of rays and sources of radiation. It is, therefore, a very appropriate time for the appearance of Mr. Hammer's book, which collects and coördinates a great deal of information hitherto widely scattered, and illustrates it by many experiments of his own. The text of the book is a reprint of a lecture delivered at a joint meeting of the American Institute of Electrical Engineers and the American Electro-chemical Society, in New York, and the illustrations are largely of apparatus and pictures shown on that occasion. An instructive account of radium and other radio-active substances, such as polonium, actinium and thorium, forms the main part of the book, but there are also interesting and suggestive considerations of phosporescent and fluorescent substances, the properties and applications of selenium, and the treatment of disease by the ultra-violet light. All these subjects are treated in a clear and simple manner, without unnecessary technicalities, and a great deal of very useful and timely information is thus placed at the disposal of a far wider audience than could be reached by the original lecture.

Standard Sections.

British Standard Sections. Issued by The Engineering Standards Committee. Supported by The Institution of Civil Engineers, The Institution of Mechanical Engineers, The Institution of Naval Architects, The Iron and Steel Institute, and The Institution of Electrical Engineers. Size, 15 by 9 in.; pp. 9; figures, 9. Price, paper, $1.00. New York; D. Van Nostrand Company.

The standard sections of structural steel shown in this pamphlet are equal angles, unequal angles, bulb angles, bulb tees, bulb plates, Z bars, channels, beams, and T bars. Each is given a full page, at the top of which is a figure of the section, and below a table, with the dimensions of the different sizes and general remarks. Of the importance of such standardization it is unnecessary to speak, and as these sections have the support of the leading British engineering societies, a knowledge of them is essential to every one concerned with structural work within the confines of the Empire.

BOOKS ANNOUNCED.

Stones for Building and Decoration. By George P. Merrill. Price, $5.00. New York; John Wiley & Sons. London, Chapman & Hall, Ltd.

Telephony. A Manual of the Design, Construction, and Operation of Telephone Exchanges. In Six Parts. By Arthur Vaughan Abbott, C. E. Price per volume, $1.50; per set, $6. New York: McGraw Publishing Co.

NEWS SUPPLEMENT

The Engineering Magazine—September, 1903

Coming Society Meetings.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Regular meeting on fourth Friday of each month, except June, July and August, 12 W. 31st St., New York.

AMERICAN INSTITUTE OF MINING ENGINEERS. Sec.: R. W. Raymond, 99 John St., New York. Next meeting, October 13, at New York.

AMERICAN MINING CONGRESS. Sec.: Irwin Mahon, Carlisle, Pa. Annual congress, September 7-12, at Deadwood and Lead, South Dakota.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting Oct. 28, at Richmond, Va.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Sec.: W. H. Johnson, Philadelphia. Convention, September 8-10, at the Thousand Islands, N. Y.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday from October to May, inclusive.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

CENTRAL STATES WATER WORKS ASSOCIATION. Sec.: Wm. Allen Veach, Newark, O. Annual convention, September 15-17, at Dayton, O.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Saturday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month, except July and August.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month, except July and Aug.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. Regular monthly meetings of the various sections on other days.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September 2-4, Atlantic City, N. J.

IOWA RAILWAY CLUB. Sec.; P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

League of American Municipalities. Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturdays.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New England Water Works Association. Sec.: Willard Kent, 715 Tremont Temple, Boston. Annual convention, September 9-11, at Montreal.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on Wednesdays.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

Pacific Northwest Society of Engineers. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R, Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signaling Club. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Roadmasters' and Maintenance of Way Association. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct. 13, 14 and 15, at Kansas City, Mo.

Rocky Mountain Railway Club. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Traveling Engineers' Association. Sec. W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

Mr. Emile Guarini, of Brussels, the well-known inventor and writer on electrical subjects, has designed an ingenious system for sending alarms of fire or notices of excessive rises of temperature by means of an automatic wireless-telegraph apparatus to any point desired and from any number of stations.

Mr. W. O. Duntley, vice-president and general manager of the Chicago Pneumatic Tool Co., has gone on a trip to the Pacific Coast in the interests of his company.

—Mr. Jas. Alex. Smith, of Melbourne, Australia, recently read a paper before the Victorian Institute of Engineers, entitled: "Notes on Internal Flow in Centrifugal Pumps. Part II. A Study of the Theory of the Runner." This paper is a continuation of one read last year before the same society, and treats the subject by analytical and experimental methods on lines differing radically from those usually followed.

Industrial Notes.

The recent launch of the "Mongolia" from the yards of the New York Shipbuilding Co., at Camden, is noteworthy on account of the size of the vessel—26,530 tons displacement, 14,000 tons dead weight

carrying capacity. This is the largest ship ever built on the Delaware, and a good-sized vessel anywhere, even in these days of marine giants. As first laid down, she was designed for the Atlantic Transport Co., but she was transferred to and completed for the Pacific Mail Co. The many attendant changes make her speedy completion the more noticeable, even considering the unusual equipment and facilities of the New York yards. The vessel is of the five-deck type, 615 by 65 by 51 feet, 12,000-horse-power, 16 knots; she is fitted with powerful steam steering and cargo-handling gear, cold storage, electric lighting, and especially complete ventilating apparatus. Steam is supplied by four double-ended and four single-ended Scotch boilers with Morrison corrugated furnaces, designed for 215 pounds working pressure, heated forced draught. The "Manchuria," a sister ship, is just about to be launched.

The American Conduit Co., of Los Angeles, Cal., the manufacturers of electrolysis-proof bituminized fibre conduits, have opened an office at 170 Broadway, New York, which will be in charge of Mr. F. C. Mott.

Within the past two years the R. D. Nuttall Company have expended a large sum for new machinery so that they could properly take care of their rapidly increasing trade, and now again they find it necessary to install 23 of the latest type gear-cutting machines as well as additional worm-gear machinery, mills. lathes, etc., to correspond. In regard to the new gear-cutting machinery, they have good reasons to believe that this is the largest individual order for this type of machine ever placed. They have also made a corresponding increase in the capacity of their power plant, and when all of the above machinery is in place, they will be operating what is probably the largest and most complete gear-cutting plant in the world.

The Omega Steel Co., of New Haven, Conn., report some very satisfactory tests of their milling cutters. At the Union Switch and Crossing Co., Swissdale, Pa., a cut 1/16 inch deep, 5/8 inch wide and 7 inches long was made on Braeburn unannealed cast steel with a milling cutter 1¾ inches in diameter and having a 2½-inch face. The cutter ran 360 revolutions and had a feed of 9½ inches per minute. At the Mesta Machine Co., West Homestead, Pa., a cutter was used which was 1¾ inches in diameter, and had a 1¾-inch face and a 7/8-inch hole. The speed was 160 revolutions per minute and the feed .036 inch per revolution. The cut, which was made on two cast-steel dies for a bolt cutter, was 1/16 inch by 1¼ inches by 5 inches, and the cutter stood the trial without injury. Still other tests were made at the Bickford Drill Co., Cincinnati, where the dimensions of the milling cutter were: diameter, 1¾ inches; face, 1¾ inches; hole, 7/8 inch. The cutter was run at 372 revolutions, with a feed of 1 inch per minute. A cut was made in machine steel 1¼ inches wide, 1/16 inch deep and 7 inches long, and in cast iron a similar cut 14 inches long, the cutter not being harmed in any way by its performance.

The Ingersoll-Sergeant Drill Company, which has placed a line of pneumatic tools on the market, reports immediate recognition of the superiority of the Haeseler "Axial Valve" hammers, upon comparative tests with other tools. Among the latest purchasers of these tools are: Niles-Bement-Pond Company; Ramapo Iron Works; MacPherson Switch & Frog Company; Creswell & Waters Company; Warren Foundry & Machine Works; Chicago, Rock Island & Pacific R. R.; Brown Hoisting & Conveying Machine Company; Howard Iron Works, and International Boiler Works Company.

In looking up the subject of durability and length of life of superheaters American engineers have generally been confronted with the necessity of turning to Europe for such experience as would give confidence in this form of apparatus. But it is interesting to note that the Hartford Electric Light Co. over two years ago installed a Foster superheater in connection with a 600-H. P. water-tubular boiler and a Westinghouse-Parsons steam turbine, and have as the result of their experience, recently placed an order with the Power Specialty Company of New York, for a duplicate plant.

The Bureau of Forestry is about to make a series of tests to determine the strength and durability of the principal merchantable timbers of the United States, on a larger

scale than that of the former tests which were in charge of the late Prof. J. B. Johnson. The officials of the Bureau fully realize that this work, which is the result of a wire-spread and urgent demand, should not be undertaken until its scope and methods have been thoroughly considered. To be thoroughly effective the plan of work should have the endorsement of leading engineers and manufacturers. This Bureau is especially anxious to get results whose authority will be unquestioned, and it has issued a circular which contains a tentative plan for future work. Copies of all publications relating to timber tests already made by the Division of Forestry will be sent with the circular to persons who are interested in this work. A full discussion of the plan for the proposed tests, and criticisms or suggestions as to its scope and methods, are generally desired. The value of the proposed investigations to engineers, foresters, lumbermen, builders, architects, and manufacturers will be greatest if a logical and systematic scheme of this kind is applied in the testing, the scope and technique of which should be fixed only after a full discussion.

An interesting proof of the progress of electrical industries is the recent shipment of a carload of electricity wattmeters (some 1,400 in number) by the Stanley Instrument Company, of Great Barrington, Mass., through Messrs. John Martin & Co., San Francisco, their Pacific Coast agents, to the Edison Electric Co., of Los Angeles, Cal. The shipment, intended for the measurement of current used in the comparatively small installations of general house lighting aggregates a total capacity of upwards of 3,000 H. P., and while the instruments are small, the total weight of the shipment is nearly 40,000 pounds. The destination, Los Angeles, California, indicates the widespread use of electrical apparatus of the highest class. The wattmeters of the Stanley Instrument Co., besides being shipped to all parts of the United States, have been sent for years to South America, Mexico, Porto Rico, etc., and since the beginning of this year, when an office was established at No. 23 Boulevard des Italiens, Paris, France, by this company, a strong demand for their wattmeters has arisen in France, Italy, Switzerland, Germany, Austria, Hungary, England and the British possessions, a pleasing manifestation of the high position obtained by American electrical manufacturers.

The Peterborough Hydraulic Power Company, of which Senator Geo. A. Cox in president, is building a new power plant on the Otonabee River in the town of Peterborough, Ontario, Canada, which will be equipped with the following apparatus recently purchased from the Westinghouse Electric & Manufacturing Company: A 1,500-kilowatt, 2,240-volt generator, having 7,200 alternations and running at 150 revolutions per minute, to be direct connected to water wheels; two 125-volt direct-current, direct-coupled exciters of 75 kilowatts capacity each; together with a switchboard consisting of a large generator panel and two exciter panels. This power house, when completed, will be an unusually fine one and is to furnish power to the Peterborough mill of the American Cereal Company, owned by the Quaker Oats Company; Power will be supplied to several other manufacturing plants in the town and also to the Peterborough Light & Power Company, which does the electric lighting and small-power business in Peterborough.

The Allis-Chalmers Co., of Chicago, report the following partial list of engine sales for July: Chicago Beach Hotel, Chicago; Knox Construction Co., Chicago; Richmond Cedar Works, Richmond, Va.; Barrett Mfg. Company, Beloit, Wis.; American Aristotype Co., Jamestown, N. Y.; Stilwell-Bierce & Smith-Vaile Co., Dayton, O.; Fourche River Lumber Co., Chicago; J. I. Case Plow Works, Racine, Wis.; Consumers' Heat & Electric Co., Bloomington, Ill.; Union Sugar Company, San Francisco, Cal.; Canton Oil Mill Co., Canton, Miss.; Mr. Henry Du Pont, Wilmington, Del.; Olds Motor Works, Lansing, Mich.; The Clayton Oil Mills, Clayton, N. C.; The Homestake Mining Co., Lead, So. Dak.; Lacey-Buek Iron Co., Birmingham, Ala.; C. A. Macdonald, Chicago; Arkansas City Milling Co., Arkansas City, Kan.; Manhattan Rubber Mfg. Co., Passaic, N. J.; Charles B. Pride, Appleton, Wis.; Columbus Buckeye Lake & Newark Traction Co., Columbus, O.; Lock, Moore & Co., Ltd., Westlake, La.; Georgia Cordage Mills, Decatur, Ga.; Marquette Cement Mfg. Co., La Salle, Ill.; Coe Brass

Mfg. Co., Torrington, Conn.; Charles Waite, South Dakota; The Gauley Company, Camden-on-Gauley, W. Va.; Rock Hill Water, Light & Power Co., Scranton, Pa.; Memphis Consolidated Gas & Electric Co., Memphis, Tenn.

The Gisholt Machine Company, of Madison, Wis., has recently amended its articles of incorporation, increasing its capital to $750,000. Up to the present time the Gisholt Company has confined itself almost exclusively to the manufacture of the now well known Gisholt lathes. These tools are made in several varieties and sizes and the line is being constantly extended. The increasing business in Gisholt lathes has necessitated a very considerable increase in the manufacturing facalities of the company, and additions have recently been made, both in buildings and equipment, that will double the former capacity of the plant. While the new buildings and equipment will be largely used for producing Gisholt lathes, they will, in part, be used for the manufacture of other types of machine tools, such as boring mills, etc. The last named machines, however, will not be manufactured on a large scale until new buildings now in contemplation are completed. Contracts have recently been made by the Gisholt Company for a large new foundry, to be equipped throughout with modern, up-to-date appliances. The building will be strictly fire-proof.

A recent testimony to the value of flexible metallic conduit was made by Vice-President and General Manager Bryan of the Interborough Rapid Transit Company in an interview published in the New York *Sun*, August 12th. Speaking of the fire-proof construction of the new cars for the subway, and the impossibility of the Paris accident being repeated in New York, he says, according to the N. Y. *Sun*: "The wiring for lighting the cars is one roof away from the passengers. Two small wires are insulated with asbestos and carried in conduits of flexible metal." The flexible metallic conduit which he refers to is that manufactured by the Sprague Electric Company, who received the order for this type of conduit for the Interborough car wiring for lights. This type of conduit is unequalled for car wiring as well as the wiring of buildings where thorough protection to wires and insulation is essential. Its flexibility is such that it can be bent around corners and over obstructions with ease, the energy required to bend it being no more than is required to bend a manila rope of the same diameter. No elbows, therefore, are required and the installation is reduced to absolute simplicity. It is self-evident that this type of conduit is well fitted to car wiring, and it is gratifying to note that the Interborough Company has taken a step forward in the hitherto careless methods of car wiring, which will insure the greatest possible safety to passengers against fire due to defective wiring.

The Duke of Marlborough, following the example of other progressive members of the British aristocracy, has ordered two electric elevators with push-button control from the Otis Elevator Company. These are to be installed in his city home, Blandford House, Curzon St., London.

The Robbins & Myers Company, of Springfield, Ohio, have been manufacturing and selling a line of direct current electric motors and dynamos, from 15 H. P. down to the smallest sizes, for about six years. All sizes of these machines have been designed on similar lines, following an ideal type for general application. When this type first appeared, it was as the exponent of a new idea in motor building—that of complete protection of armature and windings from mechanical injury, without interfering with the ventilation necessary to cool running. The type was expected to fill a place midway between the open, unprotected motor, which was the standard practice at that time, and the full enclosed motor, which required so much material per horse-power of output in order to run within a safe temperature limit. The history of subsequent motor building has justified the belief of the designers of these machines, for at present the large majority of all motors sold, under 25 H. P., either embody or point with respect to this idea of a protective design. The Robbins & Myers Company have from the first advertised these machines as being of "Our Protected Type," but many of their customers have pointed out to them that this title is no longer sufficiently distinctive, and have suggested that they adopt some name which shall apply to motors and dynamos of their manufacture only. In

pursuance of this idea, the name "Standard," so long used by them as applying to their electric fans, and for this reason so intimately associated in the minds of the public with the name of The Robbins & Myers Company, seems peculiarly appropriate. They are aware of the fact that the name "Standard," as applied to dynamo-electric machinery, is not new, but they are not aware that it is now being applied by any maker of direct-current dynamos and motors now in business, and this is to notify such makers, if they exist, and the public at large, that unless they hear in the meantime that the name has been pre-empted, The Robbins & Myers Company will expect all their products to be known as "The Standard," after September 1st, 1903.

The old and well known firm of Thos. H. Dallett & Co., of Philadelphia, has lately been reorganized and incorporated as the Thos. H. Dallett Co., with officers as follows: President, Thos. H. Dallett; vice-president and general manager, Ernest C. Bliss; secretary and treasurer, E. C. Clay; with W. H. Van Sickel, lately New York representative of the Under-Feed Stoker Co. of America, and formerly identified with the pneumatic tool industry, as superintendent. The company will greatly extend and enlarge the capacity of their plant, located at York Street and Sedgely Avenue, and while continuing the manufacturing of their well known belt and electrically driven portable drills, deck planers, etc., will devote especial attention to the production of Dallett pneumatic tools. Their works are equipped with the latest and most improved machinery, and the extensions projected are necessary to enable them to supply the demand for the Dallett tools, which have by their intrinsic merit gained an enviable reputation.

Mr. Henry Engels, located at No. 91 Fremont St., San Francisco, who represents the Chicago Pneumatic Tool Company on the Pacific Coast, has lately secured several large orders for pneumatic equipment, including a number of Franklin air compressors.

With the knowledge of what America has to offer the summer tourist and the rest and health-seeker, the thousands of summer travelers who spend their vacation in "The Highlands of Ontario," unhesitatingly pronounce the Muskoka Lakes region the ideal, the perfectly satisfying summer resort. Such an ideal is a combination of two features—primeval nature in a perfect bewilderment of beauty, charm and variety, and the modern necessaries and conveniences. Handsomely illustrated publications describing this region will be sent free on application to Mr. F. P. Dwyer, Eastern Passenger Agent of the Grand Trunk Railway System, 290 Broadway, New York.

—The Pennsylvania Railroad Company is equipping more of its offices with Nernst lamps, thereby attesting to the superiority of the illumination afforded by this now famous lamp. The Philadelphia office of the Nernst Lamp Company reports that twenty-six six-glower and five three-glower Nernst lamps have recently been installed in the freight department of the Pennsylvania Railroad at Broad and Washington Avenues, Philadelphia, this being one of the most important departments of the company. Several three-glower Nernst lamps have also been placed in the power house at Camden, N. J., and the lighting equipment at the new passenger station is about to be completed by the installation of twenty-three lamps of the three-glower type, which will be an addition to the six-glower Nernst lamps already in use. It is expected that the new shops of the Philadelphia, Baltimore and Washington branch of the Pennsylvania Railroad will be largely lighted by this illuminant, the six-glower type being used.

The Ball Engine Company, Erie, Pa., report shipments of engines for electric service during July to the following: Longmont Beet Sugar Co., Longmont, Colo.; Lookout Mountain Iron Co., Battelle, Ala.; Hamilton Hotel, Louisville, Ky.; Vermont Hospital for Insane, Waterbury, Vt.; Polyclinic Hospital, Philadelphia, Pa.; Tawas Sugar Co., East Tawas, Mich.; Alvoy & Ferguson Co., Louisville, Ky.; Owosso Sugar Co., Owosso, Mich.; Imperial Tobacco Co., Rocky Mount, N. C.; Imperial Tobacco Co., Wilson, N. C.; Pittsburg Coal Co., Alliston Mine; Federal Chemical Co., Nashville, Tenn.; Washington Elec. Light & Power Co., Washington, Pa.; Jefferson Coal Co., Piney Fork, Ohio; Manhattan Railway Co., New York, and others.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.

Boiler-Tube Cleaner.

Booklet, with illustrations and description of the "Torpedo" cleaner for tubes of return tubular boilers, which consists, essentially, of a rapidly oscillating knocker, moved along the inside of the fire tubes. Also, illustrated description of the "Demon" rotary, water-driven cleaner for water-tube boilers. 6¼ by 3½ in.; pp. 12. The General Specialty Company, Buffalo.

Compressed-Air Pumping.

Catalogue "G," giving a well illustrated and comprehensive description of systems of pumping by compressed air, including the air-lift pump and displacement pumps using air expansively, or using direct pressure of air without expansion, with views of plants in operation. 9 by 6 in.; pp. 47. Pneumatic Engineering Co., 128 Broadway, New York.

Conveying Appliances.

Catalogue No. 7, bound in flexible cloth, with illustrations, descriptions and prices of all kinds of elevating and conveying machinery and other labor-saving appliances for foundries and the coal and iron and steel industries; and also useful tables and data. 7¼ by 9¼ in.; pp. 176. Heyl & Patterson, Pittsburg.

Cranes.

Catalogue, with illustrations and descriptions of revolving pneumatic cranes, portable and stationary; hand-power jib cranes; electric locomotive revolving cranes; standard pneumatic car jacks; portable pneumatic painting machines; and other kinds of cranes and pneumatic apparatus. 5 by 7 in.; pp. 31. The Garry Iron and Steel Company, Cleveland.

Electric Motors.

Bulletin No. 136, with illustrations and descriptions of three types of S. K. C. induction motors, designed for various frequencies and potentials, and adapted to many kinds of service; also, with tables of dimensions. 10½ by 8 in.; pp. 12. Stanley Electric Manufacturing Co., Pittsfield, Mass.

Elevators.

Catalogue, with well-illustrated descriptions of elevating devices of many types, including electric, hydraulic, steam and belt-driven elevators for passengers and freight, escalators, or moving staircases, and incline railways. 9 by 8 in.; pp. 62. Otis Elevator Company, New York.

Feed-Water Purifiers.

Catalogue, with descriptions and illustrations of live-steam feed-water purifiers, exhaust-steam feed-water heaters, steam separators, oil eliminators and exhaust heads, and examples of their operation. 6 by 9 in.; pp. 40. Also, booklet, devoted to steam separators, oil eliminators and exhaust heads. 6 by 4½ in.; pp. 20. The Hoppes Mfg. Co., Springfield, Ohio.

Filing Machine.

Booklet, with illustrated description of the "Kinseyburt" filing machine for all kinds of metals, and directions for setting up and using it. A hack-saw can also be used with the machine. 6 by 3½ in.; pp. 15. Kinsey-Burt Co., 136 Liberty St., New York.

Fire Hose.

Pamphlet, with descriptions and half-tone illustrations of various styles of rubber-lined, seamless, cotton fire hose, views of the processes of its manufacture and history of the evolution of fire hose. 6¾ by 5¼ in.; pp. 48. Eureka Fire Hose Company, New York.

Grinding Machinery.

Catalogue for 1903, with descriptions and illustrations of many styles of the "Challenge" emery grinding and polishing machines, their parts and accessories, which possess many important advantages. 9¼ by 6 in.; pp. 52. Challenge Machine Co., Philadelphia.

Lathes.

Pamphlet, with half-tone illustrations, giving a full description of new bench lathes and attachments, and descriptions of recent improvements in toolmakers' lathes and engine lathes. 9 by 6 in.; pp. 67. Pratt & Whitney Co., Hartford, Conn.

Marine Hardware.

Catalogue, with illustrations, descriptions and prices of blocks, lanterns, cordage, compasses, logs, and all kinds of ship chandlery, yacht supplies and marine hardware. 9¼ by 5¾ in.; pp. 392. Chas. D. Durkee & Co., 3 and 5 South St., New York.

Oil Cups.

Folder, with illustrations and descriptions of the Tucker oil-hole covers and cups, self-closing oilers and other styles of lubricating apparatus. 6¼ by 3½ in.; pp. 4. W. W. & C. F. Tucker, Hartford, Conn.

Pencils.

Illustrated pamphlet, with conveniently arranged descriptions of pencils for every variety of service and all kinds of people, and an interesting account of the making of pencils. 8 by 5 in.; pp. 32. Also, booklet devoted to Dixon's "Eterno," the indelible pencil. 3½ by 6¼ in.; pp. 8. Joseph Dixon Crucible Company, Jersey City, N. J.

Reinforced Concrete.

Bulletin No. 20, with illustrations and description of reinforced concrete construction, and, particularly of the new paper will of the W. D. Boyce Co., Marseilles, Ill., which is built entirely of concrete and steel. 10¾ by 8 in.; pp. 4. Ambursen & Sayles, Watertown, N. Y., and Walter I. Brock, Chicago.

Respirator.

Folder, illustrating and describing the Barnum respirator, by means of which fresh air is supplied to persons working in any confined space filled with gas or foul air. 9½ by 6 in.; pp. 4. P. L. Rider, Worcester, Mass.

Rock Drills.

Catalogue No. 43, the first of a new series being issued by the Ingersoll-Sergeant Drill Co. This pamphlet has handsome half-tone illustrations and elaborate descriptions of rock drills, stone-channeling machines, quarry bars, gadders, coal cutters and other mining and quarrying machinery, and many views of their practical application in all parts of the world. 9 by 6 in.; pp. 167. Ingersoll-Sergeant Drill Co., New York.

Catalogue No. 51, with descriptions and handsome half-tone and tinted illustrations of rock drills, stone-channeling machines and other rock excavating machinery, and examples of their use. 9 by 6 in.; pp. 11. Also, catalogue No. 52, devoted to rock drills and air compressors. 9 by 6 in.; pp. 110. Sullivan Machinery Co., Chicago.

Roller Bearings.

Catalogue, with descriptions and illustrations of roller bearings for power transmission and general mill purposes, and of bearing boxes, hangers, pillow blocks and other shafting appliances. 6 by 9 in.; pp. 23. American Roller Bearing Co., Boston.

Roofing.

"A Ruberoid Album," a pamphlet devoted to the merits of Ruberoid roofing, which is waterproof, acid-proof and fire-resisting, and containing views of a great variety of buildings in all parts of the world, which are covered with this roofing. 9 by 6 in.; pp. 48. The Standard Paint Company, New York.

Steam Engines.

Catalogue, with illustrations and descriptions of the well known Reynolds-Corliss steam engines, with views of the Allis works, where they are made, and of plants in many parts of the world where they are in operation. Among the engines shown are ones for street railways, electric lighting, pumping, blowing, rolling mills, hoisting and all kinds of power purposes, as well as air compressors. 6¾ by 9¾ in.; pp. 177. Allis-Chalmers Company, Chicago.

Pamphlet, with illustrations and descriptions of direct-connected automatic cut-off steam engines of the enclosed type, built in accordance with the recent recommendations made by the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. 6 by 9 in.; pp. 6. Chandler & Taylor Co., Indianapolis.

Stokers.

Large catalogue, containing a comprehensive description of the Jones under-feed mechanical stoker and its operation, illustrated by half-tones and line engravings, and views of many steam-boiler plants where it is installed. 12 by 9 in.; pp. 48. The Under-Feed Stoker Co. of America, Chicago.

Strainer.

Booklet, illustrating and describing the King deep well strainer, made of hardened wire wound on longitudinal ribs of hard-rolled metal, for letting down inside the well castings. 6 by 3½ in.; pp. 6. The Kisinger-Ison Co., Cincinnati.

Smelting.

Illustrated pamphlet, giving a great deal of useful and up-to-date information about smelting practice and equipment for the reduction of gold, silver, lead and copper ores. 9¾ by 6¾ in.; pp. 134. The Colorado Iron Works Co., Denver.

Tempering.

Booklet telling about the hardening and tempering of steel, and of facilities and up-to-date equipment for performing such work. 5¾ by 3½ in.; pp. 7. The Bennett Tempering Co., New Britain, Conn.

Turbine Pumps.

Bulletin—Series T, No. 5, devoted to steam and electric turbine pumps, with illustrations and descriptions of De Laval steam turbines and turbine pumps direct connected. 10 by 7 in.; pp. 8. D'Olier Engineering Co., Philadelphia.

Water Wheels.

A pamphlet containing a copyrighted paper by Geo. J. Henry, Jr., entitled, "Tangential Water Wheel Efficiencies," being an experimental investigation of the relative values of different bucket shapes, with numerous illustrations, read before the Pacific Coast Electric Transmission Association. 9¼ by 6 in.; pp. 43. The Pelton Water Wheel Co., San Francisco, Cal.

Wood Pavements.

Cloth-bound book, entitled "Creo-Resinate Wood Pavements for Streets and Bridges," by F. A. Kummer, C. E., containing descriptions and illustrations of successful wood pavements in many cities, and specifications for bridge pavement. 7¾ by 5½ in.; pp. 42. Also, pamphlet with views of creo-resinate wood pavements and testimonials. 7¼ by 5¼ in.; pp. 25. United States Wood Preserving Co., 29 Broadway, New York.

Wood Pipe.

Catalogue No. 2, entitled "The Whole Story About Wood Pipe," with illustrations and descriptions of Woodward patent machine-banded wood water pipe, and Wheeler patent continuous stave pipe, and much information about wood pipe in general, including tables for flow of water through it. 7¾ by 5 in.; pp. 84. National Wood Pipe Co., Los Angeles and San Francisco, California.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Wood Pavements for Shop Floors.

ALTHOUGH a vast amount of attention is constantly given to the selection of material for the paving of streets and roads, not much is said about the best form of material for paving the floors of factories and shops and of driveways in and around the buildings of large plants. Too often manufacturers are content with the time-honored practice of laying three-inch planking for factory floors, with a full knowledge of the fact that under any considerable traffic such planking has a very short life; while the outside driveways are generally paved with cobble stone or granite, with a view to making a durable pavement, although the disadvantages of noise, lack of sanitary conditions and difficulty of traction are all present.

But in a number of instances recently a more modern practice has been followed in work of this class. One of the best examples of this may be found in the paving of the shops of the Carnegie Steel Company, at Mulhall, Pa. This company, realizing that planks laid on the flat must of necessity have a much shorter life than wood set with the grain on end, and also realizing that if wood blocks, untreated, be set with the grain on end their life would be determined, not by the rate of wear, but by the rapidity of decay, has recently laid large areas of Georgia pine blocks 8 inches long, 4 inches wide, and 4 inches deep, creosoted with 10 pounds of creosote oil to the cubic foot.

CREO-RESINATE WOOD PAVEMENT AT BROWN & SHARPE'S.

In some instances the old round cedar blocks have been used with very good results, but where the traffic is heavy and a floor is desired which will resist the dumping of castings or of any other heavy and coarse material, the best practice is probably that recently adopted by the Brown & Sharpe Manufacturing Company, of Providence, R. I. In this instance the pavement was not designed for factory shop work, but for paving the main driveway of the works, over which a very heavy

traffic passed, consisting of loads of iron, lime stone, coal, etc., for the company's furnaces. The total area paved was about 1,600 square yards, and as the cut shows, the surface of the pavement was pierced by a large number of manholes through which the coal and other material upon delivery is dumped. This pavement was therefore not only subject to heavy vehicle traffic, but also to the abrasive action of the material when dumped from the carts. Both brick and granite block had been thought of as a material for this work, but wood blocks were finally determined upon. These blocks were all heart Georgia pine, 4 inches by 4 inches by 8 inches, treated by a process known as the creo-resinate, whereby the timber was treated throughout with a mixture of creosote and melted rosin, designed not only to render the wood antiseptic and waterproof, and therefore able to resist decay, but also to harden and toughen its fibers, rendering it better able to resist abrasion. It appears also that tests of this material in Boston had demonstrated its durability; the theory being that when subjected to a pounding or abrading action of any nature the elasticity of the material enables it to sustain the shock without disintegration, while under similar conditions any non-elastic material, such as brick or granite block, shows more or less pulverizing of its surface and a consequent wearing away of its mass. The blocks were laid upon a thoroughly constructed foundation of 6-inch Portland cement concrete, on which was laid a 1-inch cushion of clean, fine sand. The blocks comprising the pavement were tightly rammed together every few courses, so as to make the joint between them as small as possible, and these joints were afterwards filled with a coating of clean, fine sand swept over the surface of the pavement until all the cracks and apertures were completely filled. This pavement has been in use at the works for seven or eight months and is giving excellent satisfaction.

Any further information desired concerning wood pavements for shops or streets will be gladly furnished by the United States Wood Preserving Co. (Creo-Resinate Process), 29 Broadway, New York.

Boiler Tube Cleaning.

IT may seem hardly possible that any one would allow scale to accumulate in boiler tubes to the thickness of an inch, and yet there are many instances where even this much or more scale is found in boiler tubes which the Lagonda Mfg. Co. are frequently called upon to clean. The cut shown herewith represents one of over 215 tubes in the boilers of a large street railway company in the South.

The engineers had no idea there was anything like this amount of scale. The water

BOILER TUBE WITH THICK SCALE.

was very bad, and the company having use for all the power the boilers could furnish, there was no opportunity to shut down. The scale accumulated before the engineers knew it, and they were about to cut out the tubes, when their attention was called to the Weinland mechanical cleaner, which they purchased, and in a very short time, with very little trouble or expense, were enabled to clean out everyone of the tubes without any injury whatever to any of them, leaving the inside in as good condition as when they were new.

The Lagonda Mfg Co. make a full line of cleaners for all kinds of boilers, notably the turbine cleaner, and their Mr. Weinland, who is a practical engineer, and the patentee of this machine, is said to be the pioneer who "blazed the way" in this line. They are ready at all times to send these machines on approval. They make a business, also, of cleaning boilers by contract, and

will be glad to enter into correspondence with anyone having inquiry to make about such work. A line to the Lagonda Mfg. Co., of Springfield, Ohio, will bring their illustrated catalogue showing boiler-tube cleaners at work and other interesting matter.

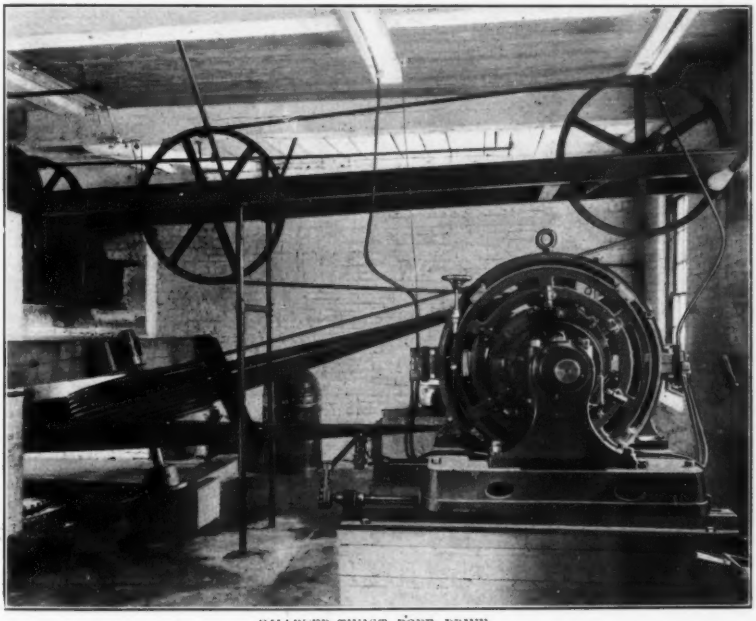
An Interesting Rope Transmission Problem.

THE situations and requirements of rope drives are such that it is very seldom that any two installations will be alike, and the engineer, in designing a new drive, is obliged to refer in almost every case to the fundamental principles governing such drives, rather than to the precedent of former experience.

An unusual problem was presented in the installation of a rope drive for Messrs James & E. H. Wilson, operating a large woolen mill at Pittsfield, Mass. The mill was formerly operated by steam power. An excellent water power, however, is located about three-quarters of a mile from the woolen mill, in a building formerly vacant, and which would probably have been abandoned were it not for the water power.

The Messrs. Wilson purchased the abandoned mill with the idea of using the water power for generating electricity, the electricity to be transmitted for driving their woolen mill, thus taking advantage of the economy of the water power over their steam plant.

The ordinary method of transmitting power from a turbine shaft by means of gears was found impracticable, and the only economical method that seemed to be available was by means of manila rope transmission. The shape and dimensions of the wheel house, however, were such that 16 feet was the greatest available distance between the vertical water-wheel shaft and the dynamo. The power to be transmitted was 200 H. P., and it is quite evident that these centers were exceedingly short for a rope transmission, especially as, on account of the vertical turbine shaft and the horizontal dynamo shaft, the drive had to be a quarter twist.



QUARTER-TWIST ROPE DRIVE.

The plant was designed and installed by H. W. Caldwell & Son Company, of Chicago, through the engineers in charge of their eastern sales and engineering office at 95 Liberty Street, New York. So far as the designers are aware, this is the shortest quarter-twist drive in use where a considerable amount of power and a number of ropes are employed.

The illustration shown will make the arrangement of the drive plain. A portion of the driving sheave can be seen at the left of the cut. The position of the generator with reference to the driving sheave is clearly shown, the receiving sheave being on the other side of the generator. The lower ropes are the pulling ropes, and the slack is taken to the tension carriage from the driving sheave over the upper groove of the deflecting idler. The one-groove re-winding idler is placed above the generator, and from there the rope passes over the tension carriage sheave and returns to the driven sheave on the generator. Particular attention is called to the quarter-twist arrangement of the ropes.

In installing the drive, the driving and driven sheaves were placed according to the usual rules for setting quarter-twist belts or ropes. The 10-groove deflecting idler was placed as nearly correct theoretically as could be, and the tension carriage and the re-winding idler were placed in position. The rope was then wound, and by raising the generator slightly the catenary of the ropes between the driving and driven sheaves was taken into account, so that the ropes would lead correctly between the two sheaves.

The speed of the ropes is about 5,000 feet per minute, and notwithstanding the short centers, high speed, and the many reverse turns, the drive has given excellent satisfaction since its installation. A recent report from the Messrs. Wilson is to the effect that the drive is working very satisfactorily, this report coming about a year after the installation of the transmission.

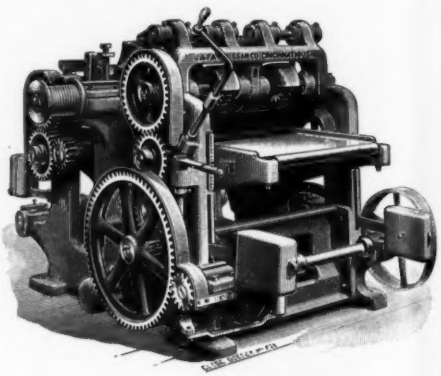
The driving sheave on the water-wheel shaft is 96 inches in diameter, running 209 revolutions per minute. The driven sheave on the generator is 34 inches in diameter, running 585 revolutions per minute. Both sheaves are grooved for ten 1⅛-inch ropes. The distance between the deflecting idler sheaves and the driven sheave is approximately 10 feet.

The engineers of the H. W. Caldwell & Son Company, having this installation in charge, feel that the successful solution of the problem is an instructive precedent for the use of rope drives in situations heretofore considered too difficult for this class of power transmission.

Any further information concerning this installation, as well as any kind of gear and power transmission machinery, will be gladly furnished by the H. W. Caldwell & Son Company, Chicago and New York.

Single-Cylinder Planer.

THE one universal demand among wood workers is for the latest and most up-to-date planer, and it is to meet this demand successfully that the new planer here shown has been built.



J. A. FAY & EGAN PLANER.

The makers of this machine have been eminently successful in building planing machinery, and it is recognized as the standard, both here and abroad. All the advantages suggested from their long experience are embodied in the make-up of this planer, which was patented December 19, 1899, and February 6, 1900, and is a powerful and substantial machine especially good for lumber mills, box factories and wood workers in general.

Among its principal features are these:

1. It has a very solid frame, and works 30 inches wide, 8 inches thick.

2. It has a powerful feed with broken feed roll made in two or four sections, and each section is center-geared. Two or more pieces of uneven thickness can thus be planed at the same time, and each piece receive an even pressure, as the roll gives any vibration desired. This point will not be lost sight of by those who have work of this character to perform.

3. It is easily operated, and all the different adjustments are quickly made, and a fine smooth finish is given to the lumber whether it be soft or hard.

The feed rolls have sectional weights, and the raising and lowering motion of the feeding-out one are parallel. The table also is easily raised and lowered, and the feed is driven from the cylinder and is always under the instant control of the operator.

Further details of this improved tool can be had on applying to its makers, J. A. Fay & Egan Co., of No. 212 to 232 West Front Street, Cincinnati, O.

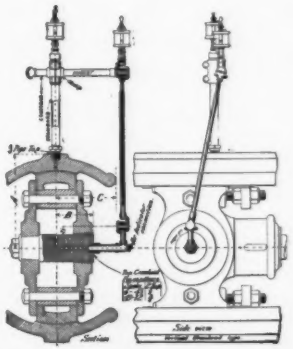
The Nugent Oiler.

THE Nugent Anti-Packed Telescopic Oiler, which is shown in the accompanying illustration, is designed to lubricate any reciprocating bearing such as the cross-head pin, eccentrics, and the double-disk crank pin of steam engines, and other similar bearings.

The anti-packed joint is the new, novel and improved feature of this invention. The joints are 1-100 of an inch loose and yet not a drop of oil can leak or waste through them. They have no stuffing-boxes, washers or packing of any kind. Thus the friction, wear and jar is practically done away with and consequently the device will outwear the engine or piece of machinery to which it is applied.

This oiling device forms a continuous conduit or channel for the oil from the stationary oil cup to the bearing which is to be lubricated. It will about treble the life of the cross-head pin, which usually wears out as fast again as the crank pin. It will save its cost in oil in a short time, over any other appliance, such as the wiper cup or grease cup. It enables the engineer to positively know whether or not the bearing is getting oil, and it places the pin or bearing under the absolute control of the engineer at all times and enables him to run his engine continuously for ten years, if necessary, without having to stop to replenish the oil, because the oil cup is always stationary. By simply pulling out two cotter pins with the fingers, the telescopic tubes and head may be removed in a moment's time.

The purchaser of this appliance takes no chances whatsoever, for perfect satisfaction is guaranteed and the money will



SECTION AND SIDE VIEW OF NUGENT'S CROSS-HEAD-PIN OILER.

be refunded any time within one year after the date of the purchase, if the oiler does not fulfill expectations. Any further information about oiling devices which may be desired will be gladly given by the manufacturers, Wm. W. Nugent & Co., 22-24 W. Randolph Street, Chicago.

Lidgerwood Derrick Engine.

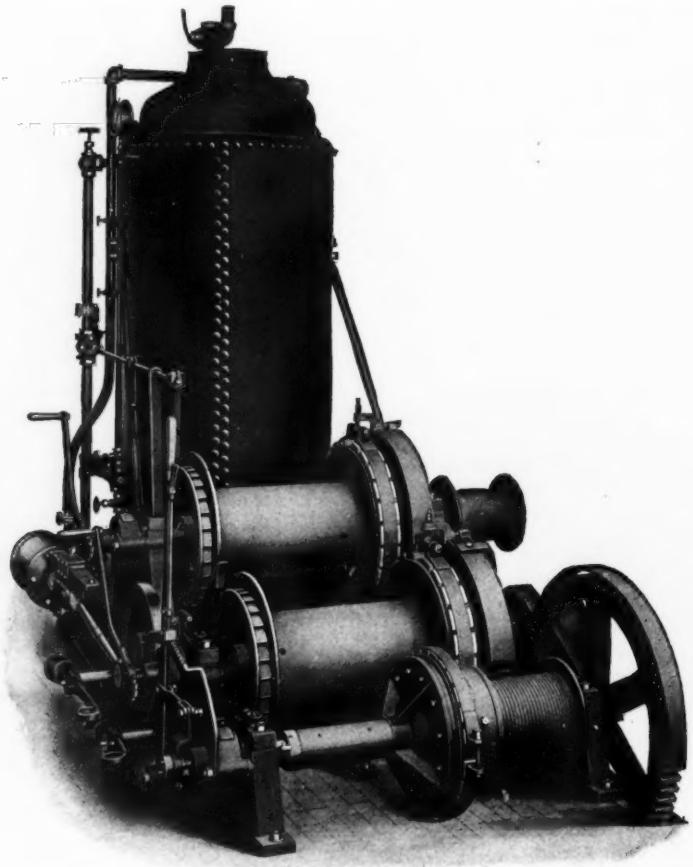
ONE of the most popular hoisting engines built by the Lidgerwood Manufacturing Co., is the derrick engine shown in the accompanying illustration, an important feature of this derrick being the new form of reversible-boom swing gear (Baechtold patent), with which the engine is equipped, and which has proved superior to any form of swinging gear heretofore used on derrick engines.

This new gear can be furnished with any of the standard Lidgerwood double-drum hoisting engines, with or without boiler. It is used in connection with a bull wheel which is recommended to be of a diameter

not less than one-fifth the length of the boom. The rope passes around the bull wheel, and from that to the drum, one end of the rope being made fast to the drum on one side, while enough of the other part of the rope to give the required amount of movement to the bull wheel is wound on the drum, and the end attached to the other side of the drum. As the drum revolves one rope winds on as the other unwinds.

Only one lever is required to operate the swinging drum. When the lever is in the center of the quadrant the drum is entirely loose on the shaft and as it is moved either forward or back is driven in either direction.

A friction cone of standard type, with screw pin, cross-key and collar, is used for turning the drum in one direction, and a differential band brake (which encircles the flange) when applied causes an internal set of gears to turn the drum in the opposite direction. This cone friction and brake are of the same type as used on the regular drum of the engine and form an efficient method of gradually checking the motion of the boom when required.



LIDGERWOOD DERRICK ENGINE.

The large gear which drives the swinging drum shaft connects with a pinion which is cast on the inner end of the forward winch head. The ratio of the two gear wheels is

such that the swinging drum turns at only one-fifth of the speed of the other drum, which slow speed admits of hoisting the load and swinging the boom simultaneously. This is affected by the operating lever, which has a thumb latch connecting with latch quadrant so that the lever may be left in any desired position without further attention from the operator until ready to check the swinging of the boom.

This swinging gear is adapted to all sizes of Lidgerwood engines, from 8 to 50 horse power.

When furnished with a new engine the bed plate can be extended to receive the drum shaft bearings of the swinging gear, making the outfit complete and self contained. In applying it to an old engine it is only necessary to remove the winch head from the lower drum shaft and replace it with the winch head furnished with the swinging gear, and then bolt the attachment to the same skids that carry the engine.

All parts of the new reversible swinging gear are made to gauge on the Lidgerwood Manufacturing Co.'s standard duplicate part system, and are kept in stock. This insures quick delivery of new gear or duplicate parts that may be needed in case of accident or breakage.

Swinging the boom by power is admittedly the modern and most economical method of operating a derrick. One engineer only is required to hoist the load, raise and lower the boom and swing the derrick, whereas by the old method of swinging by hand two men are always necessary, and frequently more.

Any further details desired will be furnished by the Lidgerwood Manufacturing Co., of 96 Liberty Street, New York.

The Ward Leonard Motor Controller.

THE successful operation of electrically driven tools was delayed considerably owing to the fact that a successful motor controller had not been perfected. The usual practice in obtaining speed variations in electrical driven machine tools still is to use a variable-speed motor, the speed variation of which is obtained by altering the field strength of the motor.

The Ward Leonard Electric Co. have, however, perfected a reversing speed controller with both armature and field control, which is shown in the accompanying illustration. The resistance material is made up of Ward Leonard enamelled resistance units, which are compact and fireproof, and have a zero temperature coefficient, the resistance wire being entirely

WARD LEONARD MOTOR CONTROLLER.

enclosed and hermetically sealed with enamel.

The armature resistance is divided into fifteen steps, and is sufficient to reduce the motor speed to half of full speed even when the motor is only one-quarter loaded, and to operate the motor from dead rest to full speed at any load from one-half normal to full load.

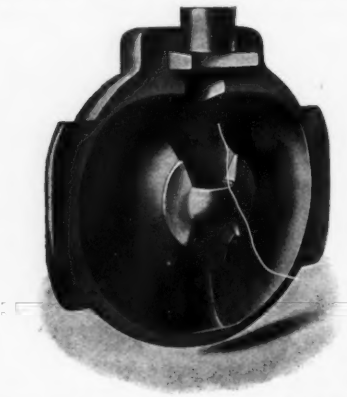
Further information about this controller, as well as about their other rheostats, current-regulating devices and various specialties, will be gladly furnished by the Ward Leonard Electric Co., of Bronxville, N. Y.

A New Valve.

A STEAM gate valve of a new and original type has recently been put on the market, a brief description of which, with illustrations showing some of its features, will be of interest. It is called the "Lenticular" double-disc taper-seat gate valve, taking its name from the design and shape of the center piece between the two discs.

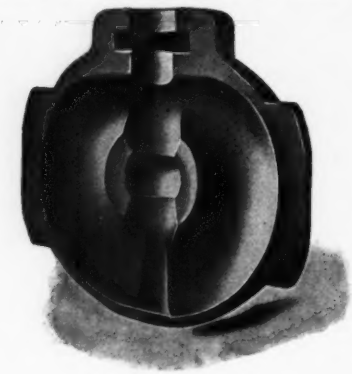
In this valve there are only four parts which are moved by the action of the screw: the two discs, the lenticular bearing or center piece, and the stem nut. The discs are provided with recesses or pockets to admit the shoulders or projections cast on the stem nut and from which the discs are sus-

pended, and on the back of each disc is a projection having its face concaved and fitted to the convex faces of the center piece, thus making a true center bearing. The construction and relation of the rings



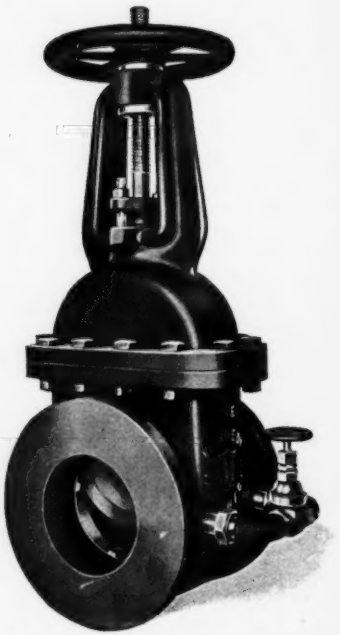
STEM NUT AND CENTER PIECE OF KENNEDY VALVE IN PLACE.

on the discs and of the center piece are such that the discs have perfect freedom of movement around the center. The discs are also provided on either side with guide wings which work between the guides cast



BEARING FOR CENTER PIECE OF KENNEDY VALVE.

in the body of the valve, and their function is to control the position of the discs when opening or closing the valve. By means of these guides the discs are held in a central position, thus making it impossible for them to come in contact with the seat rings, except at the moment of closing the valve, thereby avoiding all liability to mar or deface them. The center piece has two convex faces which are segmental faces of a true sphere, which faces are arranged in a ring form to allow the stem to pass through. The convex faces of the center piece and concave faces of the projections on the back of discs conform to each other, and when the valve is closed



OUTSIDE RISING STEM AND YOKE BY-PASS OF KENNEDY LENTICULAR GATE VALVE.

the discs are forced to their seats from the center, with an evenly distributed pressure.

This type of valve is peculiarly adapted to that class of service which is more exacting than with the ordinary range of pressures. The Kennedy Valve Mfg. Co., whose sales office is at 70 Beekman street, New York, with works at Coxsackie, N. Y., are manufacturing this valve and at present are equipped to furnish them for work- will be pleased to give any further information that may be desired.

F.ri.

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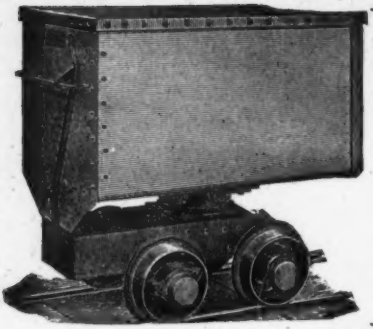

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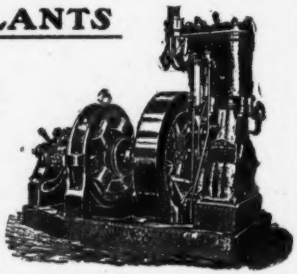

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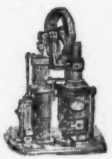

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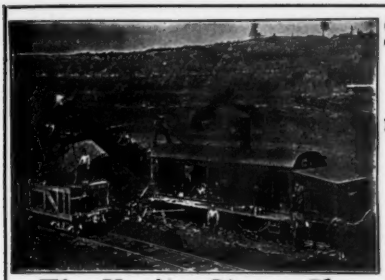

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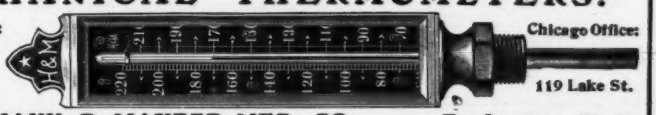

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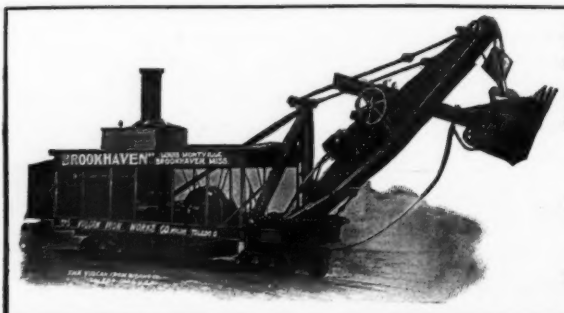

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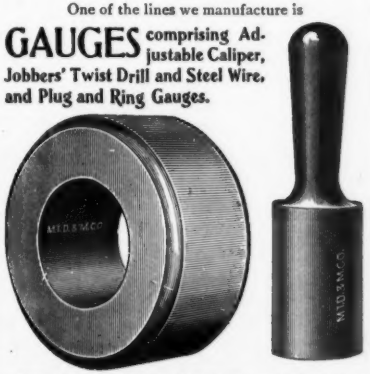

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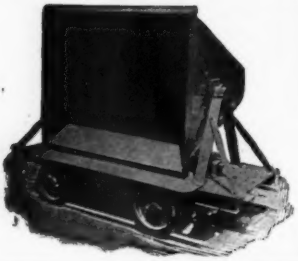

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Accumulators, Hydraulic.

Watson-Stillman Co., 204 E. 43rd St., New York.

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Manufacturers' Advertising Bureau (Benj. R. Western), 126 Liberty St., New York.

Aerial Tramways.

A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 95 Liberty St., New York.
Trenton Iron Co., Trenton, N. J.

Air and Gas Compressors.

Allis-Chalmers Co., Chicago, Ill.
American Air Compressor Works, 26 Cortlandt St., New York.
American Well Works, Aurora, Ill.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Blanchard Machine Co., Boston, Mass.
Chicago Pneumatic Tool Co., Chicago, Ill.
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Knowles Steam Pump Wks., 114 Liberty St., N. Y.
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Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Union Steam Pump Co., Battle Creek, Mich.
Vulcan Iron Works, Wilkesbarre, Pa.
Henry R. Worthington, 118 Liberty St., New York.

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Christensen Engineering Co., Milwaukee, Wis.
Westinghouse Air Brake Co., Pittsburg, Pa.

Air Chambers.

Hercules Float Works, Springfield, Mass.

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Diamond Drill & Machine Co., Birdsboro, Pa.

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Dodge Mfg. Co., Mishawaka, Ind.
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Hall Steam Pump Co., Pittsburg, Pa.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Northern Engineering Works, Detroit, Mich.
Pedrick & Ayer Co., Philadelphia, Pa.
Pneumatic Engineering Co., New York City.

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Chicago Pneumatic Tool Co., Chicago, Ill.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.

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Weston Elec. Inst. Co., Waverly Pk., Essex Co., N. J.

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Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
R. Poole & Sons Co., Baltimore, Md.
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Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Automatic Engines.

Geo. F. Woolstan, 39 Cortlandt St., New York.

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Electric Vehicle Co., 100 Broadway, New York.
Locomobile Co. of America, Bridgeport, Conn.

Auxiliary Engines.

Buffalo Forge Co., Buffalo, N. Y.
General Power Co., 81-83 Fulton St., New York.

Ballast Unloaders.

A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.

Ball Bearings.

Ball Bearing Co., Philadelphia, Pa.

Ballcocks.

Julian D'Este Company, 24 Canal St., Boston, Mass.

Band Saws.

Fay & Egan, 212-232 W. Front St., Cincinnati, O
Frank Machinery Co., Buffalo, N. Y.
Harron, Rickard & McCone, San Francisco, Cal.

Belt Dressing (Waterproof).

Jos. Dixon Crucible Co., Jersey City, N. J.
Graton & Knight, Worcester, Mass.
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Aultman Company, Canton, Ohio.
Boston Belting Co., Boston, Mass.
Case Mfg. Co., Columbus, Ohio.
Eureka Fire Hose Co., New York City.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Engineering Co., Philadelphia, Pa.

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Belt Lacing.

Bristol Co., Waterbury, Conn.
Chas. A. Schieren & Co., 45-51 Ferry St., N. Y.

Belt Lacing Machines.

Diamond Drill & Machine Co., Birdsboro, Pa.

Bending Rolls.

Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, Ohio.
Niagara Machine & Tool Works, Buffalo, N. Y.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Blast Furnaces.

Enterprise Boiler Co., Erie, Pa.
S. V. Huber & Co., Pittsburg, Pa.
Walter Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wellman-Seaver-Morgan Engng. Co., Cleveland, O.

Blowers.

American Blower Co., Detroit, Mich.
American Gas Furnace Co., 23 John St., New York.
Buffalo Forge Co., Buffalo, N. Y.
The S. Obermayer Co., Cincinnati, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
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Boiler Compounds

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Vulcan Iron Works, Toledo, Ohio.
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American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Atlas Engine Co., Indianapolis, Ind.
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Babcock & Wilcox Co., 85 Liberty St., New York.
C. H. Bradley, Jr., & Co., Pittsburg, Pa.
Enterprise Boiler Co., Youngstown, Ohio.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
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Star Drilling Machine Co., Akron, Ohio.
The Stirling Co., Chicago, Ill.
Struthers-Wells Co., Warren, Pa.
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Boiler Tube Cleaners.

Lagonda Mfg. Co., Springfield, Ohio

Bolt Cutters.

The National Machinery Co., Tiffin, O.

Bolt and Nut Machinery.

The National Machinery Co., Tiffin, O.

Books.

Association of Engineering Societies, Phila., Pa.
Derry-Collard Co., 256-257 Broadway, New York.
Henry Carey Baird & Co., 810 Walnut St., Philadelphia, Pa.
Eng'g Magazine Press, 120-122 Liberty St., N. Y.
International Text Book Co., Box 1030 Scranton, Pa.

Boring Machines.

Baush Machine Tool Co., Springfield, Mass.
Fay & Egan, 212-232 W. Front St., Cincinnati, O.
Frank Machinery Co., Buffalo, N. Y.

Boring Mills.

Baush Machine Tool Co., Springfield, Mass.
Hill, Clarke & Co., 156 Oliver St., Boston, Mas
Niles Tool Works Co., Hamilton, Ohio.
Pond Machine Tool Co., Plainfield, N. J.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

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J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio

Brass Founders' Supplies.

The S. Obermayer Co., Cincinnati, Ohio.

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Henry Maurer & Son, 420 E. 23d St., New York.
McLeod & Henry Co., Troy, N. Y.

Brick and Tile Machinery.

American Blower Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.

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American Lumber & Mfg. Co., Pittsburg, Pa.

Buckets, Automatic.

Hayward Co., 97 Cedar St., New York.

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National Machinery Co., Tiffin, Ohio.

Cable-Railway Machinery.

Allis-Chalmers Co., Chicago, Ill.
A. Leschen & Sons Rope Co., St. Louis, Mo.
John A. Mead Mfg. Co., 11 Broadway, New York.
R. Poole & Son Co., Baltimore, Md.

Cables, Electric and Submarine.

General Electric Co., New York.
Sprague Electric Co., 527 W. 34th St., New York.
Western Electric Company Chicago, Ill.

Cableways—Steam and Electric.

Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Trenton Iron Co., Trenton, N. J.

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Calculagraph Co., 9-13 Maiden Lane, New York.
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International Arithmograph Co., 380-384 Canal St., New York.
Keuffel & Esser Co., 127 Fulton St., New York.

Carborundum.

Carborundum Co., Niagara Falls, N. Y.

Cars.

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Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.

Carriage and Wagon Machinery.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Aluminum.

Paul S. Reeves & Son., Philadelphia, Pa.

Castings, Bronze.

The Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
Paul S. Reeves & Son., Philadelphia, Pa.

Castings, Iron, Steel and Brass.

E. R. Allen Foundry Co., Corning, N. Y.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Buffalo Foundry Co., Buffalo, N. Y.
Christensen Engineering Co., Milwaukee, Wis.
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Jeffrey Mfg. Co., Columbus, Ohio.
Maryland Steel Co., Sparrows Point, Md.
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McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
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U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

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Allis-Chalmers Co., Chicago, Ill.
Bethlehem Fdy. & Mch. Co., South Bethlehem, Pa.
H. W. Caldwell & Sons Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
W. D. Dunning, Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Vulcan Iron Works Co., Toledo, Ohio.

Cement—Portland.

American Cement Co., Philadelphia, Pa.
Atlas Portland Cement Co., 30 Broad St., N. Y.
Kelley Island Lime & Transport Co., Cleveland, O.
Lawrence Cement Co., 1 Broadway, New York.

Centrifugal Oiler.

Wm. W. Nugent & Co., 22-24 W. Randolph St., Chicago, Ill.

Chain Belting.

Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.

Chain Blocks.

Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Chain Making Machinery (Welded Chain).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Chemicals.

F. W. Braun & Co., Los Angeles, Cal.
Roessler & Hasslacher Chem. Co., 100 William St., New York.

Chemical Works Machinery.

Atlantic Works, East Boston, Mass.

Chemists.

Dr. Peter T. Austen, 89 Pine St., New York.
Chas. Catlett, Staunton, Va.
L. B. Darling, 79 Sabin St., Providence, R. I.
Robt. W. Hunt & Co., Chicago, Ill.

Chimneys.

Adam Weber Sons, Park Bow Bldg., New York.

Chucks

American Tool & Machine Co., Boston, Mass.
Standard Tool Co., Cleveland, Ohio.

Circuit Breakers.

The Cutler Co., Philadelphia, Pa.
Western Electric Co., Chicago, Ill.

Clay-Working Machinery.

American Blower Co., Detroit, Mich.
Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.
Vulcan Iron Works, Toledo, Ohio.

Clocks—Time Recording.

E. Imbauser & Co., 206 Broadway, New York.

Clutch Pulleys.

H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Dodge Mfg. Co., Mishawaka, Ind.

Coal and Ashes-Handling Machinery.

Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
The Hayward Co., 97 Cedar St., New York.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Coal-Mining Machinery.

Allis-Chalmers Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Buffalo Forge Co., Buffalo, N. Y.
General Electric Co., New York.
C. W. Hunt Co., West New Brighton, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Triumph Electric Co., Cincinnati, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coal-Saving Machinery.

Parson Mfg. Co., 320 Broadway, New York.

Coal Screens.

Allis-Chalmers Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.

Concentrators.

P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
Harron, Rickard & McCone, San Francisco, Cal.

Concrete Mixers.

W. D. Dunning, Syracuse, N. Y.
Ransome Concrete Mchy. Co., 11 B'way, N. Y. C.

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Alberger Condenser Co., 95 Liberty St., New York.
Allis-Chalmers Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Guild & Garrison, Brooklyn, N. Y.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
John H. McGowan Co., Cincinnati, Ohio.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Southwark Foundry & Machine Co., Phila., Pa.
Struthers-Wells Co., Warren, Pa.
Wheeler Condenser & Engineering Co., 120 Liberty St., New York.
Henry R. Worthington, 118 Liberty St., New York

Conduits.

American Conduit Co., 336 Macy St., Los Angeles, Cal.

Construction Timbers (Yellow Pine).

American Lumber & Mfg. Co., Pittsburg, Pa.

Continuous Rolling Mills.

Morgan Construction Co., Worcester, Mass.

Controllers.

The Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Power & Speed Controller Co., Boston, Mass.

Conveying Machinery.

Aultman Company, Canton, Ohio.
Browning Engineering Co., Cleveland, O.
H. W. Caldwell & Sons Co., Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hayward Co., 97 Cedar St., New York.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
H. E. Maxfield & Co., 136 Liberty St., N. Y.
John A. Mead Mfg. Co., 11 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Trenton Iron Co., Trenton, N. J.

Cooling Towers.

Alberger Condenser Co., 95 Liberty St., New York.
Wheeler Condenser & Engineering Co., 120 Liberty St., New York.
Henry R. Worthington, New York City.

Copper.

Orford Copper Co., 74 Broadway, New York.

Core Ovens.

Millett Core Oven Co., Brightwood, Mass.

Corrugated Iron.

Garry Iron & Steel Co., Cleveland, Ohio.

Cost Systems.

Baker-Vawter Co., Chicago, Ill.
Cost-System & Auditing Co., 45 B'way, New York.
Gunn & Richards, 30 Pine St., New York.
Hugo Diemer, Lawrence, Kansas.

Counting Machines.

W. N. Durant, 235 22d St., Milwaukee, Wis.

Cranes.

American Hoist & Derrick Co., St. Paul, Minn.
Browning Engineering Co., Cleveland, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Garry Iron & Steel Co., Cleveland, Ohio.
Hayward Co., 97 Cedar St., New York.
Industrial Works, Bay City, Mich.
Northern Engineering Works, Detroit, Mich.
The S. Obermayer Co., Cincinnati, Ohio.
Pedrick & Ayer Co., Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
R. D. Wood & Co., Philadelphia, Pa.

Crank Pin Oiler.

Wm. W. Nugent & Co., 22-24 W. Randolph St., Chicago, Ill.

Crucibles.

F. W. Braun & Co., Los Angeles, Cal.
The S. Obermayer Co., Cincinnati, Ohio.
R. B. Seidel, Inc., 1324-34 Callowhill St., Phila., Pa.

Crushers—Ore, Phosphate, Rock.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
F. W. Braun Co., Los Angeles, Cal.
Card & Weber Machine Co., Denver, Colo.
Diamond Drill & Machine Co., Birdsboro, Pa.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Sturtevant Mill Co., Boston, Mass.

Crusher Rings and Shells (Steel).

Latrobe Steel Co., Philadelphia, Pa.

Cupel Machines.

F. W. Braun Co., Los Angeles, Cal.

Cupolas.

Northern Engineering Works, Detroit, Mich.
The S. Obermayer Co., Cincinnati, Ohio.
Riter-Conley Mfg. Co., Pittsburg, Pa.
F. B. Stevens, Detroit, Mich.

Cutters, Milling.

Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Standard Tool Co., Cleveland, Ohio.

Diamond Drills.

American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 128 Broadway, New York.

Dies.

Geometric Drill Co., New Haven, Conn.

Die Heads.

Geometric Drill Co., New Haven, Conn

Digesters.

Atlantic Works, East Boston, Mass.
Enterprise Boiler Co., Erie, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Draw Benches, Wire.

Trenton Iron Co., Trenton, N. J.

Draught Gauges.

Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Draughtsmen's Instruments and Materials.

Theo. Altenedер & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Eugene Dietzgen Co., 181 Monroe St., Chicago, Ill.
Keuffel & Esser Co., New York.

Dredges—SEE EXCAVATORS.

Drilling Machines.

W. F. & John Barnes Co., Rockford, Ill.
Baush Machine Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Pneumatic Tool Co., Chicago, Ill.
Thos. H. Dallett & Co., Philadelphia, Pa.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Niles Tool Works Co., Hamilton, Ohio.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Railway Appliances Company, Chicago, Ill.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drills—Rock and Coal.

American Diamond Rock Drill Co., 95 Liberty St., New York.
Clayton Air Compress Wks., 120 Liberty St., N. Y.
Davis Calyx Drill Co., 128 Broadway, New York.
Hall Steam Pump Co., Pittsburg, Pa.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.

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J. Geo. Leyner, 1033 17th St., Denver, Colo.
Rand Drill Co., 128 Broadway, New York.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Dynamos.

American Engine Co., Bound Brook, N. J.
Christensen Engineering Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J.
C & C Electric Co., 143 Liberty St., New York.
General Electric Co., New York.
Guarantee Electric Co., Chicago, Ill.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
National Electric Co., Milwaukee, Wis.
Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Western Electric Company, Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Ejectors.

Hancock Inspirator Co., 85 Liberty St., New York.
Hayden & Derby Mfg. Co., New York.
Watson & McDaniel Co., Philadelphia, Pa.

Electric Clocks.

E. Imbauser & Co., 206 Broadway, New York.

Electric Counters.

W. N. Durant Co., 235 22d St., Milwaukee, Wis.

Electric Generating Plants.

General Power Co., 81-83 Fulton St., New York.

Electric Hoists.

Browning Engineering Co., Cleveland, O.
C & C Electric Co., New York, N. Y.
C. W. Hunt Co., West New Brighton, N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Northern Engineering Works, Detroit, Mich.
Shaw Electric Crane Co., Muskegon, Mich.
Sprague Electric Co., 527-531 W. 34th St., N. Y.

Electric Heating Apparatus.

Simplex Electric Heating Co., Cambridgeport, Mass.

Electrical Machinery and Supplies.

American Engine Co., Bound Brook, N. J.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Bristol Co., Waterbury, Conn.
C & C Electric Co., 143 Liberty St., New York.
Christensen Engineering Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J.
The Cutler Co., Philadelphia, Pa.
The Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
General Electric Co., New York.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
National Electric Co., Milwaukee, Wis.
Wm. E. Quimby, Inc., 86 Liberty St., New York.
The Robbins & Myers Co., Springfield, Ohio.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Ward Leonard Electric Co., Bronxville, N. Y.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Western Electric Company, Chicago, Ill.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.
Henry R. Worthington, 118 Liberty St., New York.

Electrical Wires.

American Steel & Wire Co., Chicago, Ill.

Elevators.

American Tool & Machine Co., Boston, Mass.
Aultman Co., Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Morse Elevator Works, Philadelphia, Pa.
The S. Obermayer Co., Cincinnati, Ohio.
R. Poole & Son Co., Baltimore, Md.
Triumph Electric Co., Cincinnati, Ohio.

Emery Wheels.

Carborundum Co., Niagara Falls, N. Y.
Frank Machinery Co., Buffalo, N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.

Employment Bureau.

Engineering Agency, Monadnock Blk., Chicago, Ill.
Hapgoods, 309 Broadway, New York.

Engineers, Civil.

Engineering Co. of America, 74 B'way, New York.
Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill.
Chas. C. Moore & Co., San Francisco, Cal.
Sydney F. Reynolds, Torrey, Pa.
A. W. Robinson, Montreal, Canada.
Samuel Storrow, Los Angeles, Cal.

Engineers, Electrical.

Crocker-Wheeler Co., Ampere, N. J.
Engineering Co. of America, 74 B'way, New York.
Iron City Engineering Co., Pittsburg, Pa.
Robt. McF. Doble, 314 Hayward Bldg., San Francisco, Cal.
W. K. Palmer, 401 N. Y. Life Bldg., Kansas City, Mo.
Sydney F. Reynolds, Torrey, Pa.
Philip K. Stern, 130 Fulton St., New York.

Engineers, Mechanical.

Wm. S. Aldrich, Potsdam, N. Y.
William M. Brewer, Vancouver, B. C.
Geo. M. Brill, Marquette Bldg., Chicago, Ill.
Edward S. Cobb., Los Angeles, Cal.
Engineering Co. of America, 74 B'way, New York.
Hugo Diemer, Lawrence, Kans.
Robt. McF. Doble, 314 Hayward Bldg., San Francisco, Cal.
Alfred G. Heggem, Massillon, Ohio.
Holt & Schober, 378 Bourse, Philadelphia, Pa.
S. V. Huber & Co., Pittsburg, Pa.
Julian Kennedy, Pittsburg, Pa.
Walter Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Pittsburg, Pa.
Milton L. Oglesby, David Keith Bldg., Salt Lake City, Utah.
W. K. Palmer, 401 N. Y. Life Bldg., Kansas City, Mo.
C. L. Redfield, 1563 Monadnock Block, Chicago, Ill.
Sydney F. Reynolds, Torrey, Pa.
A. W. Robinson, Montreal, Canada.
H. B. Roelker, 41 Maiden Lane, New York.
Chas. S. Sage, Wellsville, N. Y.
Philip K. Stern, 130 Fulton St., New York.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Engineers, Mining.

William M. Brewer, Vancouver, B. C.
Chas. Catlett, Staunton, Va.
L. B. Darling, Providence, R. I.
Engineering Co. of America, 74 B'way, New York.
Henshaw, Bulkley & Co., San Francisco, Cal.
Chas. F. Howe, Gainesville, Ga.
Bernard MacDonald, Spokane, Wash.
Milton L. Oglesby, David Keith Bldg., Salt Lake City, Utah.
Sydney F. Reynolds, Torrey, Pa.
Samuel Storrow, Los Angeles, Cal.

Engines, Blowing.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
Southwark Foundry & Machine Co., Phila., Pa.
Wm. Tod Co., Youngstown, O.

Engines—Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
General Power Co., 81-83 Fulton St., New York.

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Hercules Gas Engine Works, 165 First St., San Francisco, Cal.
J. D. Lyon & Co., Pittsburg, Pa.
Machinery & Electrical Co., Los Angeles, Cal.
A. Mietz, 128 Mott St., New York.
National Engineering Co., Saginaw, Mich.
Northern Engineering Works, Detroit, Mich.
Struthers-Wells Company, Warren, Pa.
Weber Gas & Gasoline Engine Co., Kansas City, Mo.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.

Engines, Stationary.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J
American Well Works, Aurora, Ill.
Atlas Engine Co., Indianapolis, Ind.
Aultman Company, Canton, Ohio.
Ball Engine Co., Erie, Pa.
Ball & Wood Co., 120 Liberty St., New York.
A. F. Bartlett & Co., Saginaw, Mich.
Bradley Mfg. Co., Allegheny, Pa.
Brown Corliss Engine Co., Corliss, Wis.
Buffalo Forge Co., Buffalo, N. Y.
Erie Pump & Engine Co., Erie, Pa.
Frick Company, Waynesboro, Pa.
Harrisburg Foundry & Machine Co., Harrisburg, Pa.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Chas. L. Heisler, M. E., Erie, Pa.
Hooven, Owens, Rentschler Co., Hamilton, Ohio.
S. W. Luitwieler Co., Los Angeles, Cal.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
Providence Engineering Works, Providence, R. I.
Reeves Engine Co., 85 Liberty St., New York.
Rider-Ericsson Engine Co., New York City.
Shepherd Engineering Co., Franklin, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Phila., Pa.
Star Drilling Machine Co., Akron, Ohio.
Struthers-Wells Company, Warren, Pa.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
The William Tod Co., Youngstown, Ohio.
Vulcan Iron Works, San Francisco, Cal.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Willamette Iron & Steel Co., Portland, Ore.
Robt. Wetherill & Co., Chester, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Evaporators.

Wheeler Condenser & Engineering Co., 120 Liberty St., New York.

Excavators.

Atlantic, Gulf & Pacific Co., Park Row Bldg., N. Y.
Bucyrus Co., So. Milwaukee, Wis.
The Hayward Co., 97 Cedar St., New York.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Exhaust Heads.

Buffalo Forge Co., Buffalo, N. Y.
Direct Separator Co., Syracuse, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Hoppes Mfg. Co., Springfield, Ohio.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.

Fans, Ventilating.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Harron, Rickard & McCone, San Francisco, Cal.
Power Specialty Co., 126 Liberty St., New York.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Western Electric Company, Chicago, Ill.

Feed-Water Heaters and Purifiers.

Allis-Chalmers Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
Goubert Mfg. Co., 85 Liberty St., New York.
Green Fuel Economizer Co., Matteawan, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Harron, Rickard & McCone, San Francisco, Cal.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Providence Engineering Works, Providence, R. I.
Ross Valve Co., Troy, N. Y.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Stewart Heater Co., Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Warren Webster & Co., Camden, N. J.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Engineering Co., 120 Liberty St., New York.

Fertilizer Machinery.

Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.

Files and Rasps.

G. & H. Barnett Co., Philadelphia, Pa.

Filters.

Enterprise Boiler Co., Erie, Pa.
L. O. Koven & Bro., New York City.
New York Cont. Jewell Filt. Co., 15 Broad St., N. Y.
Ross Valve Co., Troy, N. Y.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Fire Brick.

Henry Maurer & Son, 420 East 23d St., New York.
S. Obermayer Co., Cincinnati, Ohio.

Fireproof Building Materials.

Henry Maurer & Son, 420 East 23d St., New York.
National Fireproofing Co., Pittsburg, Pa.

Fire Pumps.

American Fire Engine Co., Seneca Falls, N. Y.

Flanges.

Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

Flexible Shafts.

Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floats.

Hercules Float Works, Springfield, Mass.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flooring, Factory.

American Lumber & Mfg. Co., Pittsburg, Pa.
U. S. Wood Preserving Co., 29 B'way, New York.

Flour Tallies.

W. N. Durant, 235 22d St., Milwaukee, Wis.

Flue Scrapers.

Lagonda Mfg. Co., Springfield, Ohio.

Fly Wheels.

Allis-Chalmers Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
R. Poole & Sons Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Robt. Wetherill & Co., Chester, Pa.

Forges.

Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Forgings, Iron and Steel.

Chester B. Albree, Allegheny, Pa.
Keystone Drop Forge Works, Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
E. M. Shaw, Providence, R. I.
Pennsylvania Steel Co., Steelton, Pa.
Wyman & Gordon, Worcester, Mass.

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Foundry Equipment.

Blanchard Machine Co., Boston, Mass.
Buffalo Foundry Co., Buffalo, N. Y.
Diamond Drill & Machine Co., Birdsboro, Pa.
A. Garrison Foundry Co., Pittsburg, Pa.
C. W. Hunt Co., West New Brighton, N. Y.
Arthur Koppel, 68 Broad St., New York.
Millett Core Oven Co., Brightwood, Mass.
Northern Engineering Works, Detroit, Mich.
S. Obermayer Co., Cincinnati, Ohio.
Pedrick & Ayer Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
F. B. Stevens, Detroit, Mich.
Whiting Foundry & Equipment Co., Harvey, Ill.

Friction Clutches.

American Tool & Machine Co., Boston, Mass.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Christiana Machine Co., Christiana, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
R. Poole & Son Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Fuel Economizers.

Green Fuel Economizer Co., Matteawan, N. Y.
Parson Mfg. Co., 320 Broadway, New York.
Providence Engineering Works, Providence, R. I.
Steam Boiler Equipment Co., 70 W. Houston St., New York.

Fuel Gas Producer.

Loomis-Pettibone Co., 52 Broadway, New York.

Furnace Builders.

American Gas Furnace Co., 23 John St., New York.
Buffalo Forge Co., Buffalo, N. Y.
Continental Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Julian Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
Parson Mfg. Co., 320 Broadway, New York.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Wellman-Seaver-Morgan Co., Cleveland, O.

Furnaces, Assayers.

F. W. Braun & Co., Los Angeles, Cal.

Gages—Pressure, Steam, Water, etc.

American Steam Gauge & Valve Co., Boston, Mass.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.
John Simmons Co., 110 Centre St., New York.
Star Brass Mfg. Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.

Galvanizing.

W. T. Flanders, Branford, Conn.
L. O. Koven & Bro., New York City.
John Simmons Co., 110 Centre St., New York.

Galvanizing Machinery and Furnaces (Wire).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Gas and Gasolene Engines.

H. E. Maxfield & Co., 136 Liberty St., N. Y.

Gas Exhausters.

American Blower Co., Detroit, Mich.
B. F. Sturtevant Co., Boston, Mass.

Gas Holders and Regulators.

Continent. Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Gaskets, Rubber.

Boston Belting Co., Boston, Mass.

Gas Machines and Generators.

American Gas Furnace Co., 23 John St., New York.
Duff's Patents Co., Pittsburg, Pa.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Morgan Construction Co., Worcester, Mass.
R. D. Wood & Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gear Cutting Machines.

Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Gould & Eberhardt, Newark, N. J.

Gearing.

Allis-Chalmers Co., Chicago, Ill.
Hugo Bilgram, 440 No. 12th St., Philadelphia, Pa.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
H. W. Caldwell & Son Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Works Co., Dayton, O.
Dodge Mfg. Co., Mishawaka, Ind.
Gould & Eberhardt, Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Morse Elevator Works, Philadelphia, Pa.
New Process Rawhide Co., Syracuse, N. Y.
R. D. Nuttall Co., Pittsburg, Pa.
R. Poole & Son Co., Baltimore, Md.
William Sellers & Co., Inc., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Stow Flexible Shaft Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Pa.

Grain Elevator Machinery.

Allis-Chalmers Co., Chicago, Ill.
Aultman Co., Canton, Ohio.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Graphite.

Jos. Dixon Crucible Co., Jersey City, N. J.
The S. Obermayer Co., Cincinnati, Ohio.

Grinding and Polishing Machinery.

Brown & Sharpe Mfg. Co., Providence, R. I.
Diamond Machine Co., Providence, R. I.
Dodge Mfg. Co. Mishawaka, Ind.
Harron, Rickard & McCone, San Francisco, Cal.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Landis Tool Co., Waynesboro, Pa.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
F. L. Smidth & Co., 63 Maiden Lane, New York.
Stow Flexible Shaft Co., Philadelphia, Pa.

Hangers—SEE PULLEYS.

Heading and Upsetting Machines.

National Machinery Co., Tiffin, Ohio.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Hayden & Derby Mfg. Co., New York.
John Simmons Co., 110 Centre St., New York.
Sprague Electric Co., 527 W. 34th St., New York.
H. B. Smith Co., 137 Centre St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Walworth Mfg. Co., Boston, Mass.

Hoisting Crabs.

Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Hoisting Engines and Machinery.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
A. F. Bartlett & Co., Saginaw, Mich.
Browning Engineering Co., Cleveland, Ohio.

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Chicago Pneumatic Tool Co., Chicago, Ill.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
General Power Co., 81-83 Fulton St., New York.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
The Hayward Co., 97 Cedar St., New York.
Hendrie & Bolthoff Mfg. & Supply Co., 1601 Seventeenth St., Denver, Colo.
C. W. Hunt Co., West New Brighton, New York.
Industrial Works, Bay City, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Machinery & Electrical Co., Los Angeles, Cal.
H. E. Maxfield & Co., 136 Liberty St., N. Y.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
John A. Mead Mfg. Co., 11 Broadway, New York.
Niles Tool Works Co., Hamilton, Ohio.
Northern Engineering Works, Detroit, Mich.
Providence Engineering Works, Providence, R. I.
Railway Appliances Co., Chicago, Ill.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Sprague Electric Co., 527-531 W. 34th St., N. Y.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, O.
Weber Gas & Gasoline Engine Co., Kansas City, Mo.

Hollow Chisel Mortisers.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Hose.

Boston Belting Co., Boston, Mass.
Eureka Fire Hose Co., New York City.

Hydraulic Machinery.

Christiana Machine Co., Christiana, Pa.
Harron, Rickard & McCone, San Francisco, Cal.
S. V. Huber & Co., Pittsburg, Pa.
John H. McGowan Co., Cincinnati, Ohio.
S. Morgan Smith Co., York, Pa.
Pelton Water Wheel Co., San Francisco, Cal.
R. Poole & Son Co., Baltimore, Md.
Power Specialty Co., 126 Liberty St., New York.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Rams.

Pelton Water Wheel Co., San Francisco, Cal.
Power Specialty Co., 126 Liberty St., New York.

Hydraulic Tools.

Diamond Drill & Machine Co., Birdsboro, Pa.
Power Specialty Co., 126 Liberty St., New York.

Ice-Making and Refrigerating Machinery.

Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Frick Company, Waynesboro, Pa.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
H. B. Roelker, 41 Maiden Lane, New York.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Vulcan Iron Works, San Francisco, Cal.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Henry R. Worthington, 118 Liberty St., New York.

Impulse Water Wheels.

Pelton Water Wheel Co., San Francisco, Cal.
Power Specialty Co., 126 Liberty St., New York.

Incandescent Lamps—SEE LAMPS, ELECTRIC.

Injectors.

Hayden & Derby Mfg. Co., New York.
The Lunkenheimer Co., Cincinnati, Ohio.
John Simmons Co., 110 Centre St., New York.
Wm. Sellers & Co., Philadelphia, Pa.

Inspirators.

Hancock Inspirator Co., 85 Liberty St., New York.

Instruments, Surveying and Engineering.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Eugene Dietzgen Co., Chicago, Ill.
Keuffel & Esser Co., New York City.
Young & Sons, Philadelphia, Pa.

Insulated Wire.

American Steel & Wire Co., Chicago, Ill.
General Electric Co., New York.
Sprague Electric Co., 527 W. 34th St., New York.

Insulating Materials.

Sterling Varnish Co., Pittsburg, Pa.
Xylotite Mfg. Co., Cincinnati, Ohio.

Internal Gearing.

R. D. Nuttall Co., Pittsburg, Pa.

Jacks.

Duff Mfg. Co., Pittsburg, Pa.
Garry Iron & Steel Co., Cleveland, Ohio.

Jacks, Hydraulic.

Watson-Stillman Co., New York City.

Jet Apparatus.

Hancock Inspirator Co., 85 Liberty St., New York.
Hayden & Derby Mfg. Co., New York.

Keyseaters.

Morton Mfg. Co., Muskegon Heights, Mich.

Kiers.

Atlantic Works, East Boston, Mass.

Laboratory Supplies.

F. W. Braun & Co., Los Angeles, Cal.

Lamps, Electric.

General Electric Co., New York.
General Incandescent Lamp Co., Cleveland, Ohio.
Sterling Electrical Mfg. Co., Warren, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Western Electric Company, Chicago, Ill.

Lathes.

American Tool & Machine Co., Boston, Mass.
W. F. & John Barnes Co., Rockford, Ill.
Diamond Machine Co., Providence, R. I.
A. Garrison Foundry Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Leather, Hydraulic, Valve and Pump.

Chas. A. Schieren & Co., 45-51 Ferry St., New York.

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Leather Packing.

Detroit Leather Specialty Co., Detroit, Mich.

Light Railways.

Dodge Mfg. Co., Mishawaka, Ind.
C. W. Hunt Co., West New Brighton, New York.
Arthur Koppel, 68 Broad St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.

Lockers.

Merritt & Co., Philadelphia, Pa.
Narragansett Machinery Co., Providence, R. I.

Locomotive Cranes.

Browning Engineering Co., Cleveland, Ohio.
Industrial Works, Bay City, Mich.

Locomotives, Compressed Air.

Baldwin Locomotive Works, Phila, Pa.
H. K. Porter Co., Pittsburg, Pa.

Locomotives, Electric.

Baldwin Locomotive Works, Philadelphia, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
H. K. Porter Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Locomotives, Steam.

American Locomotive Co., 25 Broad St., New York.
Baldwin Locomotive Works, Philadelphia, Pa.
Lima Locomotive & Machine Co., Lima, Ohio.
H. K. Porter Co., Pittsburg, Pa.
Rogers Locomotive Works, Paterson, N. J.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricating and Oiling Devices.

Harron, Rickard & McCone, San Francisco, Cal.
Wm. W. Nugent & Co., 22-24 W. Randolph St., Chicago, Ill.

Machinery Exhibit.

Bourse, Philadelphia, Pa.

Machine Tools and Supplies.

American Tool & Machine Co., Boston, Mass.
W. F. & John Barnes Co., Rockford, Ill.
Baush Machine Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Crane Co., Chicago, Ill.
The Curtis & Curtis Co., Bridgeport, Conn.
Gould & Eberhardt, Newark, N. J.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Hilles & Jones Co., Wilmington, Del.
Jones & Lamson Machine Co., Springfield, Vt.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Niles Tool Works Co., Hamilton, O.
Pearson Machine Co., Chicago, Ill.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Walworth Manufacturing Co., Boston, Mass
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Whitcomb Mfg. Co., Worcester, Mass.

Machine Keys.

Morton Mfg. Co., Muskegon Heights, Mich.

Machinists' Small Tools.

Buffalo Forge Co., Buffalo, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Geometric Drill Co., New Haven, Conn.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.

Mechanical Draft.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Metal Saw Machinery.

Harron, Rickard & McCone, San Francisco, Cal.
Railway Appliances Co., Chicago, Ill.

Meters, Electric.

General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.

Milling Machines.

Adams Company, Dubuque, Iowa.
American Tool & Machine Co., Boston, Mass.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Henshaw, Bulkley & Co., San Francisco, Cal.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Milling Tools.

Geometric Drill Co., New Haven, Conn.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.

Mill Supplies.

Harron, Rickard & McCone, San Francisco, Cal.
Phillips Mine & Mill Supply Co., Pittsburg, Pa.

Mine Cars.

Allis-Chalmers Co., Chicago.
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Kilbourne & Jacobs Mfg. Co., Columbus, O.
Arthur Koppel, 68 Broad St., New York.
Lima Locomotive and Machine Co., Lima, O.
Wonham-Magor Eng'g Wks., 29 B'way, New York.
Watt Mining Car Wheel Co., Barnesville, Ohio.

Mining Machinery.

Allis-Chalmers Co., Chicago, Ill.
American Diamond Rock Drill Co., 95 Liberty St., New York.
A. F. Bartlett & Co., Saginaw, Mich.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Card & Weber Machine Co., Denver, Colo.
Davis Calyx Drill Co., 128 Broadway, New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Diamond Drill & Machine Co., Birdsboro, Pa.
General Electric Co., New York.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Henshaw, Bulkley & Co., San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
The Machinery & Electrical Co., Los Angeles, Cal.
Marion Steam Shovel Co., Marion, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Phillips Mine & Mill Supply Co., Pittsburg, Pa.
Power Specialty Co., 126 Liberty St., New York.
Providence Engineering Works, Providence, R. I.

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Pulsometer Steam Pump Co., New York City.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Trenton Iron Works Co., Trenton, N. J.
Vulcan Iron Works, San Francisco, Cal.
Vulcan Iron Works Co., Toledo, Ohio.
Watt Mining Car Wheel Co., Barnesville, Ohio.
Webster, Camp & Lane Machine Co., Akron, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Henry R. Worthington, 118 Liberty St., New York.

Mining Screens—SEE SCREENS.

Motor Controllers.

Ward Leonard Electric Co., Bronxville, N. Y.

Motors, Electric.

American Engine Co., Bound Brook, N. J.
C & C Electric Co., 145 Liberty St., New York.
Christensen Engineering Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Guarantee Electric Co., Chicago, Ill.
Jantz & Leist Electric Co., Cincinnati, Ohio
Jeffrey Mfg. Co., Columbus, Ohio.
National Electric Co., Milwaukee, Wis.
The Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
Stow Mfg. Co., Binghamton, N. Y.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Western Electric Company, Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Motors, Kerosene.

General Power Co., 81-83 Fulton St., New York.

Moulding Machines.

Frank Machinery Co., Buffalo, N. Y.
S. Obermayer Co., Cincinnati, Ohio.
Tabor Mfg. Co., 1742 Hamilton St., Philadelphia, Pa.
Power Specialty Co., 126 Liberty St., New York.

Muffles and Annealing Furnaces (Wire).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Naphtha Gas Machines.

American Gas Furnace Co., 23 John St., New York.

Nickel.

Benedict & Burnham Mfg. Co., Waterbury, Conn.
Orford Copper Co., 74 Broadway, New York.

Nozzles.

R. B. Seidel, Inc., 1324-34 Callowhill St., Phila., Pa.

Nozzle and Sleeve Press.

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Nut Tappers.

National Machinery Co., Tiffin, Ohio.

Oak Timbers.

American Lumber & Mfg. Co., Pittsburg, Pa.

Oil Burners.

C. A. Hammel, 120 W. Fifth St., Los Angeles, Cal.

Oil Engines.

General Power Co., 81-83 Fulton St., New York.

Oil Separators.

Austin Separator Co., Detroit, Mich.
Harrison Safety Boiler Works, 3138 No. Seventeenth St., Philadelphia, Pa.

Oiling and Lubricating Devices.

Wm. W. Nugent & Co., 22-24 W. Randolph St., Chicago, Ill.

Open Hearth Furnaces.

G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Wellman-Seaver-Morgan Co., Cleveland, O.

Ore-Roasting Machinery.

Allis-Chalmers Co., Chicago, Ill.

Packing.

Boston Belting Co., Boston, Mass.
Broderick & Bascom Rope Co., St. Louis, Mo.
Detroit Leather Specialty Co., Detroit, Mich.
Jenkins Brothers, 71 John St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.

Packing, Metallic.

Hileman-James Co., Pittsburg, Pa.

Paints and Varnishes.

Atlas Railway Supply Co., Chicago, Ill.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
Garry Iron & Steel Co., Cleveland, Ohio.
Paraffine Paint Co., San Francisco, Cal.
Standard Paint Co., 100 William St., New York.
Sterling Varnish Co., Pittsburg, Pa.

Paper-Mill Machinery.

Aultman Company, Canton, Ohio.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Henry R. Worthington, 118 Liberty St., New York.

Patent Attorneys.

C. A. Dieterich, 229 Broadway, New York.
Evans, Wilkins & Co., Evans Building, Washington, D. C.
Philip K. Stern, 130 Fulton St., New York.

Pattern-Makers' Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Pattern Makers.

Diamond Drill & Machine Co., Birdsboro, Pa.

Perforated Metal.

Robt. Aitchison Perforated Metal Co., Chicago, Ill.
Allis-Chalmers Co., Chicago, Ill.
H. W. Caldwell & Sons Co., Chicago, Ill.
Hendrick Mfg. Co., Carbondale, Pa.

Phosphor Bronze.

Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
R. Poole & Sons Co., Baltimore, Md.
Paul S. Reeves & Son., Philadelphia, Pa.

Pinions.

A. Garrison Foundry Co., Pittsburg, Pa.

Pipe.

American Spiral Pipe Works, Chicago, Ill.
Enterprise Boiler Co., Youngstown, Ohio.
Garry Iron & Steel Co., Cleveland, Ohio.
L. O. Koven & Bro., 50 Cliff St., New York.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Nason Mfg. Co., 71 Fulton St., New York.
Pelton Water Wheel Co., San Francisco, Cal.
The Michigan Pipe Co., Bay City, Mich.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.
U. S. Wind Engine & Pump Co., Batavia, Ill.
Weigele Riveted Steel Pipe Works, Denver, Colo.

Pipe Coverings.

F. J. Gast, 23 Dey St., New York.
Michigan Pipe Co., Bay City, Mich.

Pipe-Cutting and Threading Machines.

Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Cox & Sons Company, Bridgeton, N. J.
Harron, Rickard & McCone, San Francisco, Cal.
Niles Tool Works Co., Hamilton, Ohio.

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Pratt & Whitney Co., Hartford, Conn.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast-Iron.

Kelly & Jones Co., Greensburg, Pa.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Nason Mfg. Co., 71 Fulton St., New York.
Pelton Water Wheel Co., San Francisco, Cal.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Pipe Vises.

John Simmons Co., 110 Centre St., New York.

Planers.

Frank Machinery Co., Buffalo, N. Y.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Hilles & Jones Co., Wilmington, Del.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Whitcomb Mfg. Co., Worcester, Mass.
W. A. Wilson, Rochester, N. Y.

Planing Mill Machinery.

Buffalo Forge Co., Buffalo, N. Y.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Harron, Rickard & McCone, San Francisco, Cal.

Platinum Ware.

F. W. Braun Co., Los Angeles, Cal.

Plumbago.

S. Obermayer Co., Cincinnati, Ohio.
F. B. Stevens, Detroit, Mich.

Pneumatic Riveters.

Thos. H. Dallett & Co., Philadelphia, Pa.

Pneumatic Tools.

Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compress. Wks., 114 Liberty St., N. Y.
Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Thos. H. Dallett & Co., Philadelphia, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Railway Appliances Co., Chicago, Ill.
Rand Drill Co., 128 Broadway, New York.
Standard Railway Equipment Co., St. Louis, Mo.

Pop Safety Valves.

Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Star Brass Mfg. Co., Boston, Mass.

Portable Drilling Machines.

Thos. H. Dallett & Co., Philadelphia, Pa.

Power Hammers.

H. G. Barr, Worcester, Mass.
Beaudry & Co., 147 Milk St., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Power-Transmission Machinery.

Broderick & Bascom Rope Co., St. Louis, Mo.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Works Co., Dayton, O.
Dodge Mfg. Co., Mishawaka, Ind.
General Electric Co., New York.
Hayward Co., 97 Cedar St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Niles Tool Works Co., New York, N. Y.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
S. Morgan Smith Co., York, Pa.
Sprague Electric Co., 527 W. 34th St., New York.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Pressed Steel Barrels.

Pressed Steel Tank Co., Milwaukee, Wis.

Presses and Dies.

The Curtis & Curtis Co., Bridgeport, Conn.
Niagara Machine & Tool Works, Buffalo, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Pressure Regulators—Steam, Water and Air.

Julian D'Este Company, 24 Canal St., Boston, Mass.
Foster Engineering Co., Newark, N. J.

Prospecting Drills.

American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Star Drilling Machine Co., Akron, Ohio.

Production Engineers.

Gunn & Richards, 30 Pine St., New York.

Pulleys, Shafting and Hangers.

Allis-Chalmers Co., Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Case Mfg. Co., Columbus, Ohio.
Christiana Machine Co., Christiana, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Fay & Egan, 212-232 W. Front St., Cincinnati, O.
Frank Machinery Co., Buffalo, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Keasey Pulley Co., Toledo, Ohio.
Niles Tool Works Co., New York, N. Y.
R. Poole & Son Co., Baltimore, Md.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Xylotite Mfg. Co., Cincinnati, Ohio.

Pulverizers.

F. W. Braun Co., Los Angeles, Cal.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.

Pumps and Pumping Machinery.

Alberger Condenser Co., 95 Liberty St., New York.
Allis-Chalmers Co., Chicago, Ill.
American Fire Engine Co., Seneca Falls, N. Y.
American Well Works, Aurora, Ill.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Bacon Air Lift Co., 92 William St., New York.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Bucyrus Co., So. Milwaukee, Wis.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Clayton Air Compress. Wks., 114 Liberty St., N. Y.
The Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Epping-Carpenter Co., Pittsburg, Pa.
Erie Pump & Engine Co., Erie, Pa.
Flint & Walling Mfg. Co., Kendallville, Ind
General Power Co., 81-83 Fulton St., New York.
Guild & Garrison, Brooklyn, N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
The Laidlaw-Dunn-Gordon Co., 116 Liberty St., New York
S. W. Luitwieler Co., Los Angeles, Cal.
Machinery & Electrical Co., Los Angeles, Cal.

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John H. McGowan Co., Cincinnati, Ohio.
Morris Machine Works, Baldwinsville, N. Y.
Pneumatic Eng'g Co., 128 Broadway, N. Y.
Providence Engineering Works, Providence, R. I.
Pulsometer Steam Pump Co., 135 Greenwich St., New York.
Wm. E. Quimby, 86 Liberty St., New York.
Rider-Ericsson Eng. Co., 35 Warren St., New York.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Watson-Stillman Co., New York City.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Engineering Co., 120 Liberty St., New York.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 118 Liberty St., New York.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Pump Valves.

Boston Belting Co., Boston, Mass.
Power Specialty Co., 126 Liberty St., New York.

Punching and Shearing Machinery.

Bethlehem Foundry & Mch. Co., So. Bethlehem, Pa.
Buffalo Forge Co., Buffalo, N. Y.
Harron, Rickard & McCone, San Francisco, Cal.
Hilles & Jones Co., Wilmington, Del.
A. Garrison Foundry Co., Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
The National Machinery Co., Tiffin, O.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
R. D. Wood & Co., Philadelphia, Pa.

Purge Apparatus.

Hancock Inspirator Co., 85 Liberty St., New York.

Quarrying Machinery.

Broderick & Bascom Rope Co., St. Louis, Mo.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, New York
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., New York City.
John H. McGowan Co., Cincinnati, Ohio.
Pulsometer Steam Pump Co., New York City.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works Co., Toledo, Ohio.
Wonham-Magor Eng'g Wks., 29 B'way, New York.

Radiators.

A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City, N. J.
John Simmons Co., 110 Centre St., New York.
H. B. Smith Co., 137 Centre St., New York.

Racks—Machine Cut.

R. D. Nuttall Co., Pittsburg, Pa.

Rail Braces.

Atlas Railway Supply Co., Chicago, Ill.
Wonham-Magor Eng'g Wks., 29 B'way, New York.

Rail Joints.

Atlas Railway Supply Co., Chicago, Ill.

Railways, Industrial.

Wonham-Magor Eng'g Wks., 29 B'way, New York.

Railway Shop Machinery.

Chester B. Albree, Allegheny, Pa.
Armstrong Mfg. Co., Bridgeport, Conn.
W. F. & John Barnes Co., Rockford, Ill.
Bickford Drill & Tool Co., Cincinnati, Ohio.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Gould & Eberhardt, Newark, N. J.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works, Hamilton, Ohio.
Norwalk Iron Works, South Norwalk, Conn
Pedrick & Ayer Co., Philadelphia, Pa.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Railway Appliances Co., Chicago, Ill.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson-Stillman Co., 210 E. 43d St., New York.

Railway Specialties.

Atlas Railway Supply Co., Chicago, Ill.
Goodwin Car Co., 96 Fifth Ave., New York.
C. W. Hunt Co., West New Brighton, N. Y.
Arthur Koppel, 68 Broad St., New York.
Maryland Steel Co., Sparrows Point, Md.
John A. Mead Mfg. Co., New York City.
Pennsylvania Steel Co., Steelton, Pa.
H. K. Porter Co., Pittsburg, Pa.
Pratt & Whitney Co., Hartford, Conn.
Railway Appliances Co., Chicago, Ill.
Sprague Electric Co., 527 W. 34th St., New York.
Star Brass Mfg. Co., Boston, Mass.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Air Brake Co., Pittsburg, Pa.
Wonham-Magor Eng'g Wks., 29 B'way, New York.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Reamers.

Standard Tool Co., Cleveland, Ohio.

Refrigerating Machinery—SEE ICE-MAKING MACHINERY.

Revolution Counters.

Wm. W. Nugent & Co., 22-24 W. Randolph St., Chicago, Ill.

Rheostats.

The Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Simplex Electric Heating Co., Cambridgeport, Mass.

Riveted Pipe.

Abendroth & Root Mfg. Co., Newburgh, N. Y.
L. O. Koven & Bro., 50 Cliff St., New York.

Riveted Steel.

Pelton Water Wheel Co., San Francisco, Cal.

Riveting Machines.

Chester B. Albree, Allegheny, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Hilles & Jones Co., Wilmington, Del.
The National Machinery Co., Tiffin, O.
Niles Tool Works Co., Hamilton, Ohio.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Railway Appliances Co., Chicago, Ill.
Rand Drill Co., 128 Broadway, New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Railway Equipment Co., St. Louis, Mo.
R. D. Wood & Co., Philadelphia, Pa.

Road-Making Machinery.

Aultman Co., Canton, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Rock Breakers.

Allis-Chalmers Co., Chicago, Ill.
Aultman Co., Canton, Ohio.
Harron, Rickard & McCone, San Francisco, Cal.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Sturtevant Mill Co., Boston, Mass.

Roofing.

Garry Iron & Steel Co., Cleveland, Ohio.
Paraffine Paint Co., San Francisco, Cal.
Standard Paint Co., 100 William St., New York.

Rolling Mill Machinery.

Diamond Drill & Machine Co., Birdsboro, Pa.
A. Garrison Foundry Co., Pittsburg, Pa.
R. Poole & Son Co., Baltimore, Md.
Robt. Wetherill & Co., Chester, Pa.

Rolls, Chill and Sand.

A. Garrison Foundry Co., Pittsburg, Pa.

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Roofing Paints and Varnish.

Paraffine Paint Co., San Francisco, Cal.
Standard Paint Co., 100 William St., New York.

Rope Transmission.

Aultman Company, Canton, Ohio.
Broderick & Bascom Rope Co., St. Louis, Mo.
H. W. Caldwell & Sons Co., Chicago, Ill.
Crocker-Wheeler Co., Ampere, N. J.
Dodge Mfg. Co., Mishawaka, Ind.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Providence Engineering Works, Providence, R. I.
S. Morgan Smith Co., York, Pa.

Rotary Pumps—Hand and Power.

American Fire Engine Co., Seneca Falls, N. Y.

Rubber Goods.

Boston Belting Co., Boston, Mass.
Jenkins Bros., 71 John St., New York.

Rubber Washing Machinery.

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Sand Mixers and Sifters.

Gould & Eberhardt, Newark, N. J.
The S. Obermayer Co., Cincinnati, Ohio.

Sand Pumps.

Card & Weber Machine Co., Denver, Colo.

Saw-Mill Machinery.

Allis-Chalmers Co., Chicago, Ill.
A. F. Bartlett & Co., Saginaw, Mich.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, San Francisco, Cal.

Scales and Balances.

Wm. Ainsworth & Sons, Denver, Col.
F. W. Braun & Co., Los Angeles, Cal.

Schools.

Brooklyn Polytechnic Institute, Brooklyn.
Brown University, Providence, R. I.
Clarkson School of Technology, Potsdam, N. Y.
Georgia School of Technology, Atlanta, Ga.
Harvard University, Cambridge, Mass.
Lafayette College, Easton, Pa.
Lehigh University, So. Bethlehem, Pa.
Lewis Institute, Chicago, Ill.
Mass. Institute of Technology, Boston, Mass.
McGill University, Montreal.
Michigan College of Mines, Houghton, Mich.
Michigan Military Academy, Orchard Lake, Mich.
New York Military Academy, Cornwall, N. Y.
Norwich University, Northfield, Vt.
Pennsylvania Military College, Chester, Pa.
Pennsylvania State College, State College, Pa.
Polytechnic Institute of Brooklyn, New York City.
Pratt Institute, Brooklyn, N. Y.
Rensselaer Polytechnic Institute, Troy, N. Y.
Rose Polytechnic Institute, Terre Haute, Ind.
Sheffield Scientific School of Yale University, New Haven, Conn.
Stevens Institute of Technology, Hoboken, N. J.
Thayer School of Civil Engineering, Hanover, N. H.
Tufts College, Tufts College, Mass.
University of Kansas, Lawrence, Kan.
University of Pennsylvania, Philadelphia, Pa.
University of Vermont, Burlington, Vt.
University of Wisconsin, Madison, Wis.

Screens, Mining.

Robert Aitchison Perforated Metal Co., Chicago, Ill.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Henshaw, Bulkley Co., San Francisco, Cal.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Screw-Cutting Die Heads.

Geometric Drill Co., New Haven, Conn.

Screw Machines.

Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Separators, Steam and Oil.

Allis-Chalmers Co., Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Austin Separator Co., Detroit, Mich.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Goubert Mfg. Co., 85 Liberty St., New York.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Watson & McDaniel Co., Philadelphia, Pa.

Sewer Pipe Presses and Dies (Clay).

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Shafting—SEE PULLEYS.

Shapers.

Frank Machinery Co., Buffalo, N. Y.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Shears—SEE PUNCHING MACHINERY.

Sheet Metal Work.

Garry Iron & Steel Co., Cleveland, Ohio.

Shutters, Steel Rolling.

Kennear Mfg. Co., Columbus, Ohio.

Skylights and Ventilators.

Garry Iron & Steel Co., Cleveland, Ohio.

Spike Machines.

National Machinery Co., Tiffin, Ohio.

Spiral Gears.

R. D. Nuttall Co., Pittsburg, Pa.

Stamp Mills.

Harron, Rickard & McCone, San Francisco, Cal.

Stand Pipes.

Enterprise Boiler Co., Youngstown, Ohio.
Struthers-Wells Co., Warren, Pa.

Steam Engine Indicator.

Star Brass Mfg. Co., Boston, Mass.

Steam-Regulating Appliances.

American Steam Gauge & Valve Co., Boston, Mass.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
Julian D'Este Co., 24 Canal St., Boston, Mass.
Foster Engineering Co., Newark, N. J.
F. W. Foster Mfg. Co., Boston, Mass.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Jenkins Brothers, 71 John St., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Williams Gauge Co., W. Pittsburg, Pa.

Steam Pile Hammers.

A. F. Bartlett & Co., Saginaw, Mich.

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Steam Separators.

Austin Separator Co., Detroit, Mich.
Harrison Safety Boiler Works, 3138 No. Seventeenth St., Philadelphia, Pa.

Steam Shovels.

Bucyrus Co., So. Milwaukee, Wis.
C. W. Hunt Co., West New Brighton, N. Y.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.

Steam Specialties.

Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Ashton Valve Co., Boston, Mass.
Austin Separator Co., Detroit, Mich.
Crane Co., Chicago, Ill.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
F. W. Foster Mfg. Co., Boston, Mass.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
Lunkenheimer Co., Cincinnati, Ohio.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Nason Mfg. Co., 71 Fulton St., New York.
John Simmons Co., 110 Centre St., New York.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wm. H. Wilkinson & Co., 352 Atlantic Ave., Boston, Mass.
Wright Mfg. Co., Detroit, Mich.

Steam Superheaters.

Power Specialty Co., 136 Liberty St., New York.
Providence Engineering Works, Providence, R. I.

Steam Traps.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Eureka Iron Co., 59-61 So. Canal St., Chicago, Ill.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City, N. J.
John Simmons Co., 110 Centre St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wright Mfg. Co., Detroit, Mich.

Steel.

Wm. Jessop & Sons, Ltd., 91 John St., New York.
Latrobe Steel Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Pennsylvania Steel Co., Steelton, Pa.
E. M. Shaw, Providence, R. I.
Taylor Iron and Steel Co., High Bridge, N. J.
Walworth Manufacturing Co., Boston, Mass.
Willamette Iron & Steel Wks., Portland, Ore.

Steel Flanges.

Latrobe Steel Co., Philadelphia, Pa.

Steel Stacks.

Struthers-Wells Co., Warren, Pa.

Steel Tanks.

L. O. Koven & Bro., 50 Cliff St., New York City.
Pressed Steel Tank Co., Milwaukee, Wis.

Stokers—Mechanical.

Babcock & Wilcox Co., 85 Liberty St., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Stoppers.

R. B. Seidel, Inc., 1324-34 Callowhill St., Phila., Pa.

Storage Batteries.

Electric Storage Battery Co., Philadelphia, Pa.

Structural Iron Work.

Chester B. Albree, Allegheny, Pa.
American Bridge Co., 100 Broadway, N. Y.
Browning Engineering Co., Cleveland, Ohio.
Enterprise Boiler Co., Youngstown, Ohio.
Garry Iron and Steel Co., Cleveland, O.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

Sugar-House Machinery.

American Tool & Machine Co., Boston, Mass.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Switchboards.

Western Electric Co., Chicago, Ill.

Tanks, Iron.

Allis-Chalmers Co., Chicago, Ill.
Atlantic Works, East Boston, Mass.
Aultman Company, Canton, Ohio.
Ralph B. Carter, N. Y. City.
Enterprise Boiler Co., Youngstown, Ohio.
Flint & Walling Mfg. Co., Kendallville, Md.
L. O. Koven & Brother, 50 Cliff St., New York.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
S. Morgan Smith Co., York, Pa.
Struthers-Wells Co., Warren, Pa.
Robt. Wetherill & Co., Chester, Pa.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Tanks, Riveted Steel.

Lacy Mfg. Co., 334 N. Main St., Los Angeles, Cal.

Tanks, Wood.

W. E. Caldwell Co., Louisville, Ky.
Ralph B. Carter, 26 Cortlandt St., New York.
Flint & Walling Mfg. Co., Kendallville, Md.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Taps and Dies.

Crane Co., Chicago.
Geometric Drill Co., New Haven, Conn.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Taps—Collapsing.

Geometric Drill Co., New Haven, Conn.

Tapping and Reaming Machines.

Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.

Telephones.

Ericsson Telephone Co., 296 Broadway, New York

Tenoning Machines.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Thermometers.

Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Time Recorders.

Am. Watchman's Time Detector Co., Cleveland, O.

Tin Plate Mills.

Diamond Drill & Machine Co., Birdsboro, Pa.

Tire Plates.

Atlas Railway Supply Co., Chicago, Ill.

Tires—Steel.

Latrobe Steel Co., Philadelphia, Pa.

Tool Holders.

Fay & Scott, Dexter, Me.

Transportation.

Atchison, Topeka & Santa Fe Ry. System, Chicago, Ill.
"Big Four" Route, Cincinnati, O.
Chicago & Alton Ry. Co., Chicago, Ill.
Chicago, Hamilton & Dayton R. R., Chicago, Ill.
Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.
Denver & Rio Grande R. R., Denver, Colo.
Illinois Central R. R., Chicago, Ill.
Lackawanna Railroad, New York City.
Monon Route, Chicago, Ill.

Traveling Cranes.

Case Mfg. Co., Columbus, Ohio.
Shaw Electric Crane Co., Muskegon, Mich.
Yale & Towne Mfg. Co., 9-13 Murray St., New York.

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Traveling Derricks.

Hayden & Derby Mfg. Co., New York.
Hayward Co., 97 Cedar St., New York.

Trolleys.

Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Trolley Track.

Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Trucks.

City Forge & Iron Works, Dayton, O.

Tumbling Mills.

S. Obermayer Co., Cincinnati, Ohio.

Turbine Water-Wheels.

Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Works Co., Dayton, O.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
R. Poole & Son Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Webster, Camp & Lane Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Turnbuckles.

John Simmons Co., 110 Centre St., New York.

Turn Tables.

Dodge Mfg. Co., Mishawaka, Ind.
Arthur Koppel, 68 Broad St., New York.
Wm. Sellers & Co., Philadelphia, Pa.

Turret Lathes.

American Tool & Machine Co., Boston, Mass.
Jones & Lamson Machine Co., Springfield, Vermont, U. S. A.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Turret Tools.

Geometric Drill Co., New Haven, Conn.

Twist Drills.

Standard Tool Co., Cleveland, Ohio.

Vacuum and Draft Gauges.

Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Vacuum Pumps.

Alberger Condenser Co., 95 Liberty St., New York.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Clayton Air-Compress. Wks., 114 Liberty St., N. Y.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Guild & Garrison, Brooklyn, N. Y.
John H. McGowan Co., Cleveland, Ohio.
Pearson Machine Co., Chicago, Ill.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Valves—Gas, Steam, and Water.

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Boston Belting Co., Boston, Mass.
Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
F. W. Foster Mfg. Co., Boston, Mass.
Hancock Inspirator Co., 85 Liberty St., New York.
Jenkins Bros., 71 John St., New York.
Kelly & Jones Co., Greensburg, Pa.
Kennedy Valve Mfg. Co., 70 Beekman St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Nason Mfg. Co., 71 Fulton St., New York.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Ross Valve Co., Troy, N. Y.
John Simmons Co., 110 Centre St., New York.
Star Brass Mfg. Co., Boston, Mass.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wellman-Seaver-Morgan Eng'ng Co., Cleveland, O.

Ventilating Appliances—SEE HEATING AND VENTILATING.

Wage Calculators.

Calculagraph Co., 9-13 Maiden Lane, New York.

Watchman's Clocks.

E. Imhauser & Co., 206 Broadway, New York.

Water-Closets.

John Simmons Co., 110 Centre St., New York.

Water Heaters.

Hayden & Derby Mfg. Co., New York.

Water Lifts.

American Well Works, Aurora, Ill.
Bacon Air Lift Co., 92 William St., New York.
Clayton Air Compress. Wks., 114 Liberty St., N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Pneumatic Engineering Co., 128 B'way, N. Y.

Water Meters.

Builders' Iron Foundry, Providence, R. I.
John Simmons Co., 110 Centre St., New York.
Henry R. Worthington, New York City.

Water Power Installation.

Dayton Globe Iron Works Co., Dayton, O.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.

Water Purifier—Electric.

American Electric Improvement Co., Phila., Pa.

Water Purifying Apparatus.

Harrison Safety Boiler Works, 3138 No. Seventeenth St., Philadelphia, Pa.

Water Purifying Systems.

American Electric Improvement Co., Phila., Pa.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

Water Softening Apparatus.

Harrison Safety Boiler Works, 3138 No. Seventeenth St., Philadelphia, Pa.
New York Continental Jewell Filtration Co., 15 Broad St., New York.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

Water Tube Boilers.

Abendroth & Root Mfg. Co., Newburgh, N. Y.
Babcock & Wilcox Co., 85 Liberty St., New York.
C. H. Bradley, Jr., & Co., Pittsburg, Pa.
Heine Safety Boiler Co., St. Louis, Mo.
Kingsford Foundry and Machine Co., Oswego, N. Y.
The Stirling Co., Chicago, Ill.
Taylor Water Tube Boiler Co., Detroit, Mich.
Wickes Bros., Saginaw, Mich.

Water-Wheel Governors.

Lombard Governor Co., Boston, Mass.
Sturgess Governor Eng'ng Co., West Troy, N. Y.

Water-Works Pumping Machinery.

Allis-Chalmers Co., Chicago, Ill.
Bacon Air Lift Co., 92 William St., New York.
Geo. F. Blake Mfg. Co., 114 Liberty St., New York.
Deane Steam Pump Co. of Holyoke, 116 Liberty St., New York.
Knowles Steam Pump Wks., 114 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., 116 Liberty St., N. Y.
Snow Steam Pump Works, 116 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Robt. Wetherill & Co., Chester, Pa.

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R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 118 Liberty St., New York.

Water-Works Supplies.

American Well Works, Aurora, Ill.
W. E. Caldwell Co., Louisville, Ky.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Power Specialty Co., 126 Liberty St., New York.
John Simmons Co., 110 Centre St., New York.
Star Drilling Machine Co., Akron, Ohio.
U. S. Cast Iron Pipe & Foundry Co., Phila., Pa.
R. D. Wood & Co., Philadelphia, Pa.

Welding Compound.

M. H. Dingee, Lynchburg, Va.

Well-Sinking and Prospecting Machinery.

American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Star Drilling Machine Co., Akron, Ohio.
Williams Bros., Ithaca, N. Y.

Wells—Artesian.

Bacon Air Lift Co., 92 William St., New York.

Well Supplies.

John Simmons Co., 110 Centre St., New York.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Winches—Safety.

Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Wind Mills.

W. E. Caldwell Co., Louisville, Ky.
Flint & Walling Mfg. Co., Kendallville, Ind.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Wire-Drawing Machinery.

Morgan Construction Co., Worcester, Mass.
Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Wire, Insulated—SEE INSULATED WIRE.

Wire Nail Machinery.

National Machinery Co., Tiffin, Ohio.

Wire Mills Machinery.

Turner, Vaughn & Taylor Co., Cuyahoga Falls, O.

Wire Rope.

American Steel & Wire Co., Chicago, Ill.
Broderick & Bascom Rope Co., St. Louis, Mo.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Phosphor Bronze Smelt. Co., Ltd., Philadelphia, Pa.
Trenton Iron Co., Trenton, N. J

Wire Rope Tramways and Ropeways.

Broderick & Bascom Rope Co., St. Louis, Mo.
Vulcan Iron Works, San Francisco, Cal.

Wood-Working Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Frank Machinery Co., Buffalo, N. Y.
Harron, Rickard & McCone, 21 Fremont St., San Francisco, Cal.
H. B. Smith Machine Co., Smithville, N. J.

Worm Gearing.

R. D. Nuttall Co., Pittsburg, Pa.

Worms.

R. D. Nuttall Co., Pittsburg, Pa.

Wrenches.

Coes Wrench Co., Worcester, Mass.
John Simmons Co., 110 Centre St., New York.

Brown & Sharpe Mfg. Co.

B·S

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Our Entire Plant

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Others find them economical and convenient for cleaning small parts of machines and tools.

A coil of steam pipe heats the water in which a quantity of soda has been placed and pieces immersed in this solution dry without rusting.

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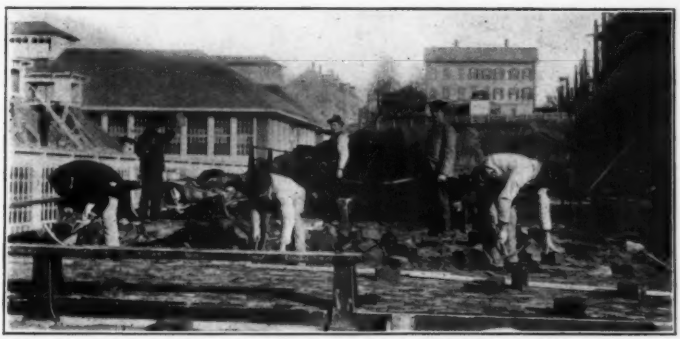

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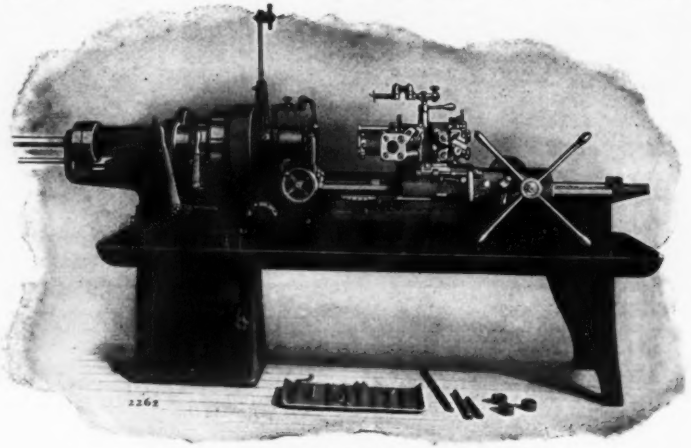

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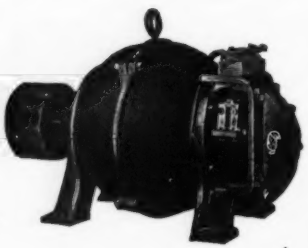

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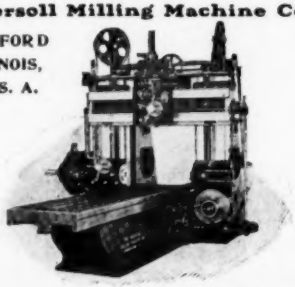

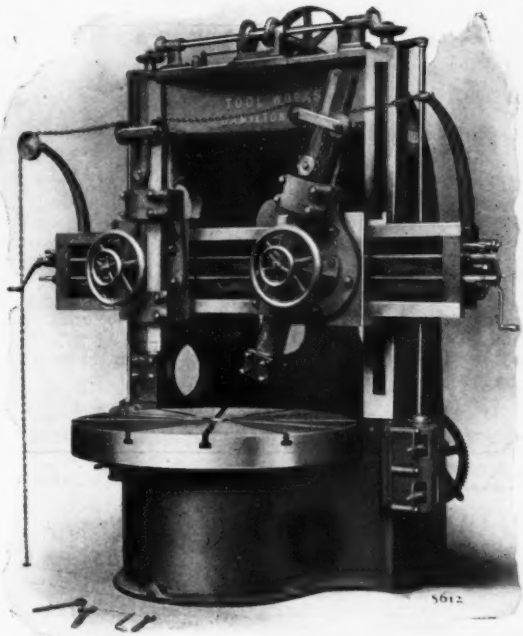

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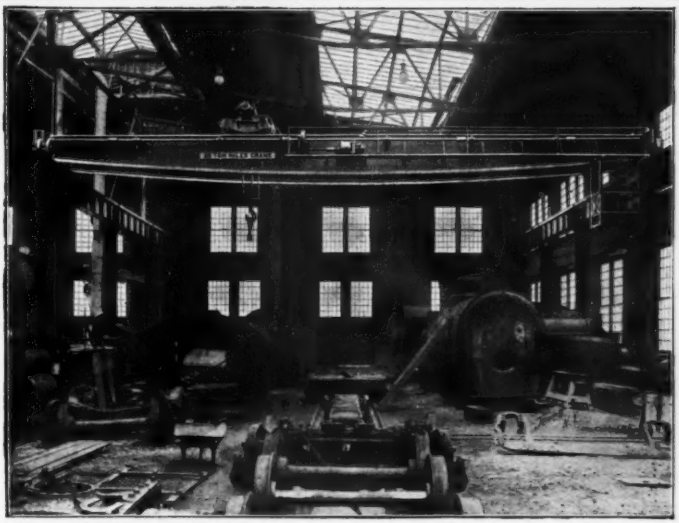

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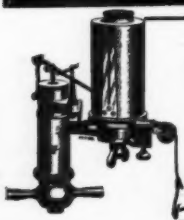

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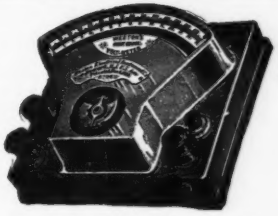

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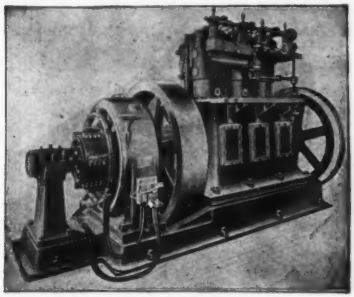

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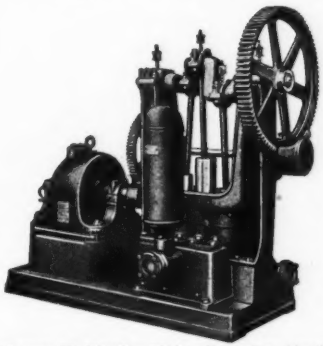

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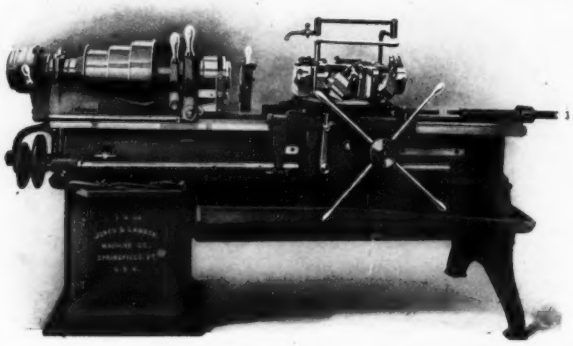

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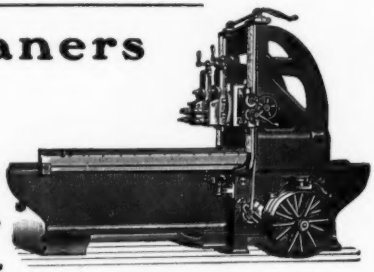

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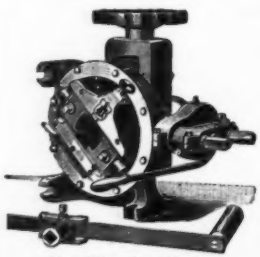

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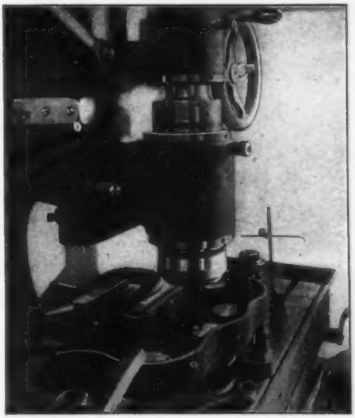

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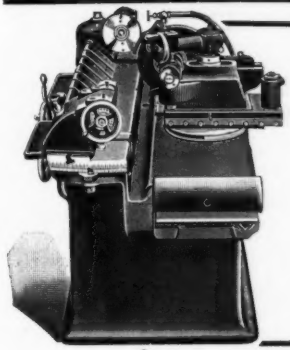

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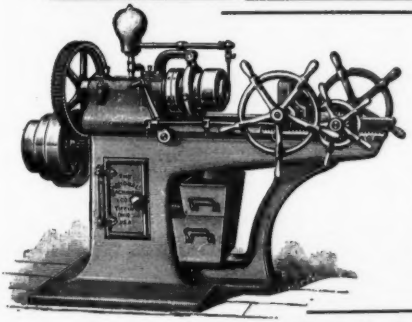

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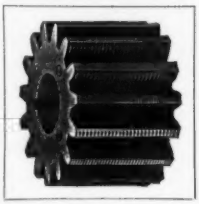

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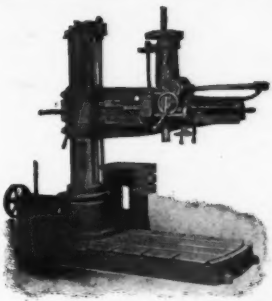

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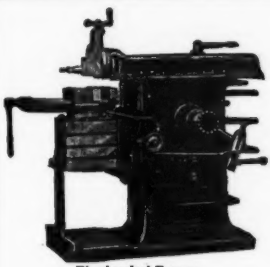

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Score, 6 to 1

In favor of Keller Pneumatic Tools.

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Two years ago (April, 1900), suit was begun by the Chicago Pneumatic Tool Co. on the Bates patent for pneumatic hammers. On July 23d, 1903, Judge Lacombe, of the U. S. Circuit Court, dismissed the bill of complaint, deciding that the KELLER hammer was not an infringement.

Out of seven suits brought against us by the Chicago Pneumatic Tool Co., six have already been decided in our favor. The only other suit is one relating to the feed-screw on rotary drills, which will be tried during the coming fall, a temporary injunction having been granted by the Court. As the feed-screw is not used at all on nine-tenths of our drills, this suit is unimportant, although when tried it will probably make the score 7 to 0.

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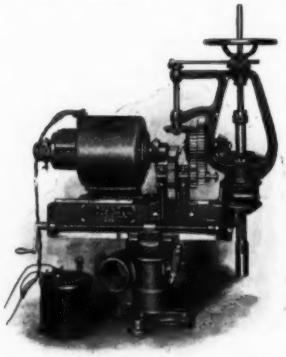

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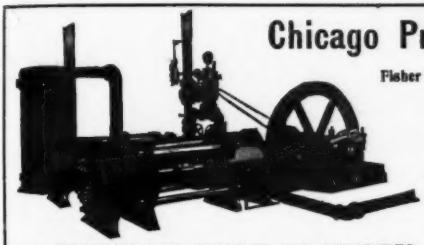

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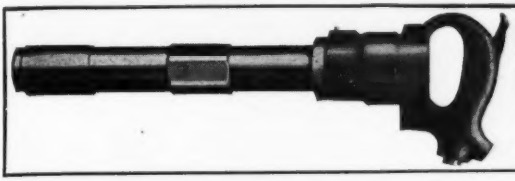

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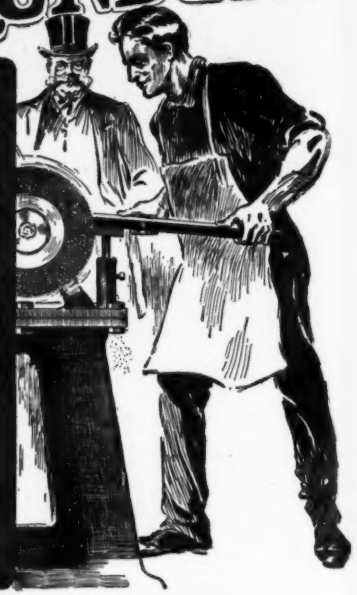

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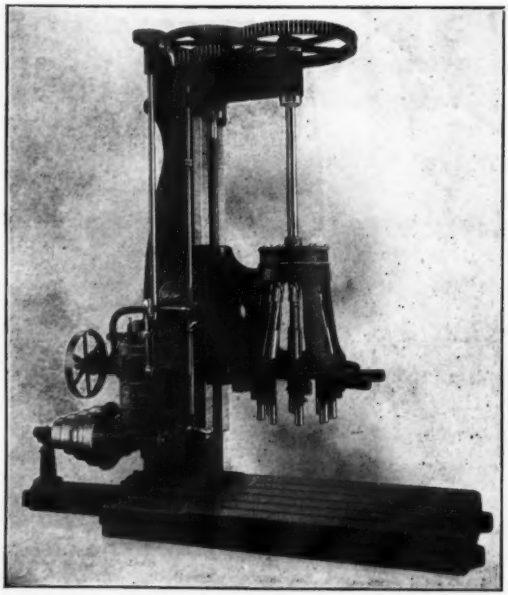

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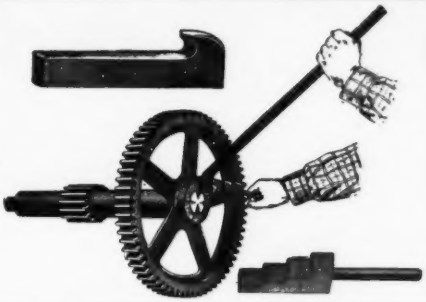

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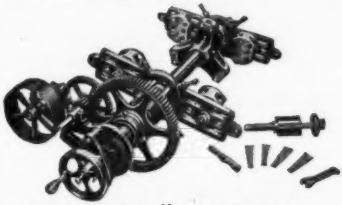

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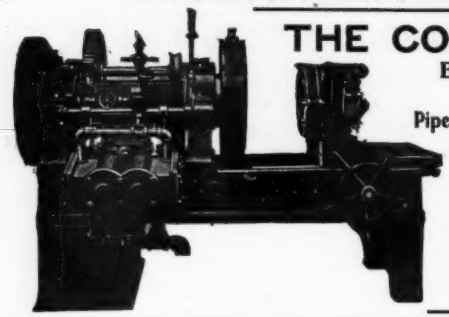

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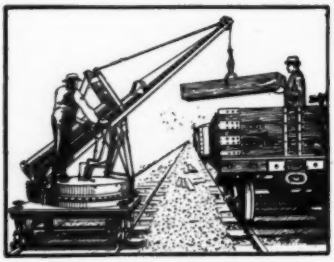

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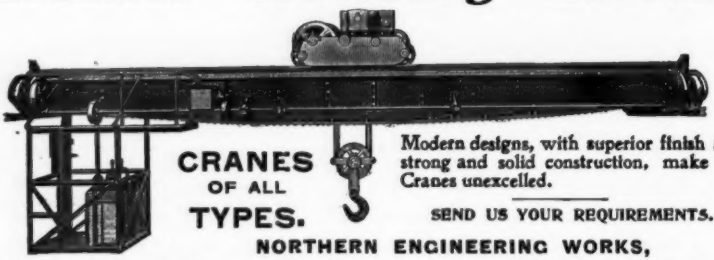

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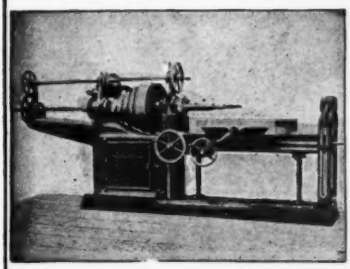

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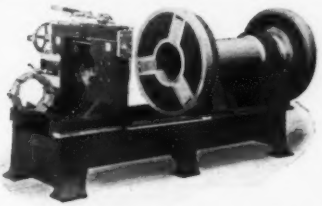

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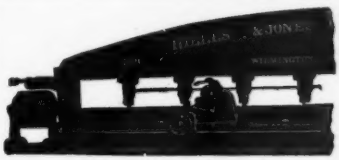

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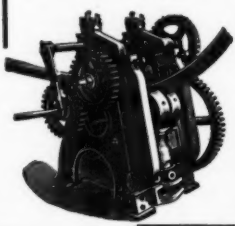

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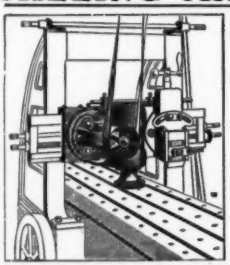

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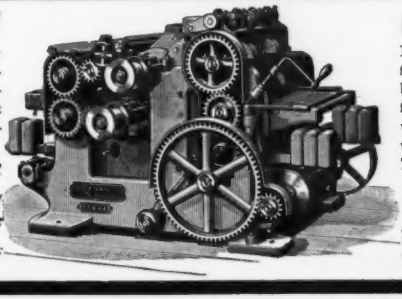

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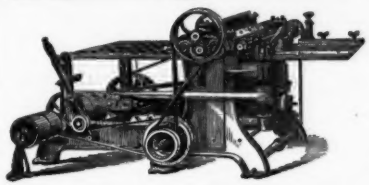

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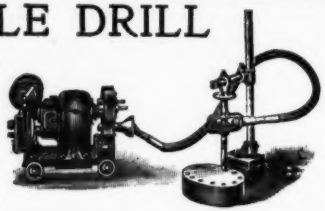

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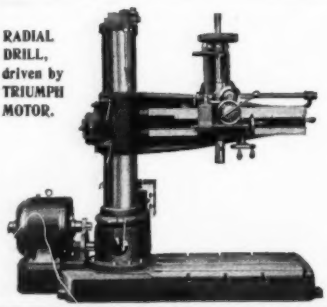

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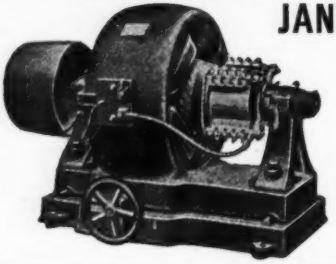

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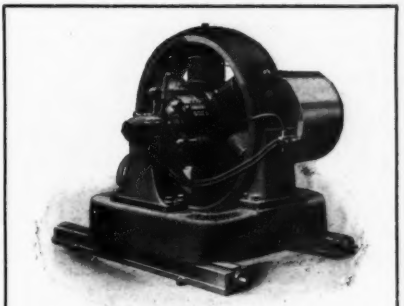

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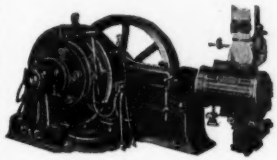

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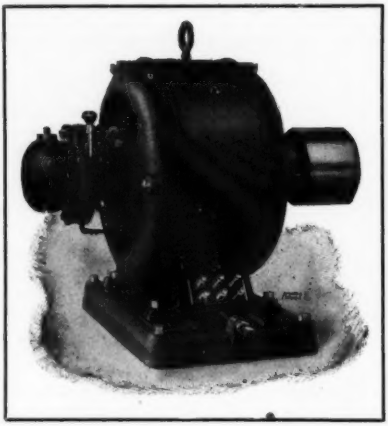

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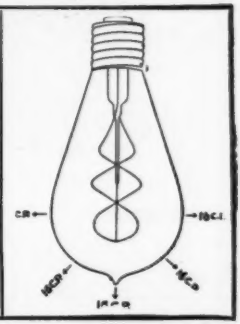

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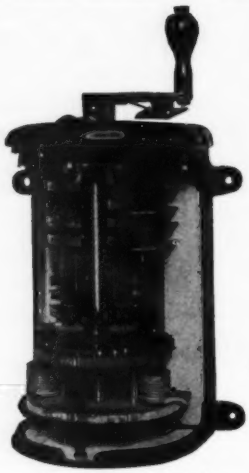

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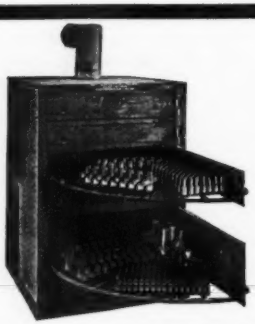

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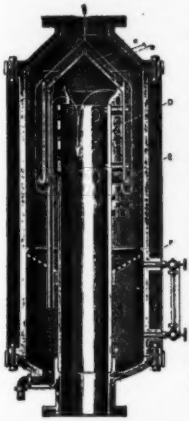

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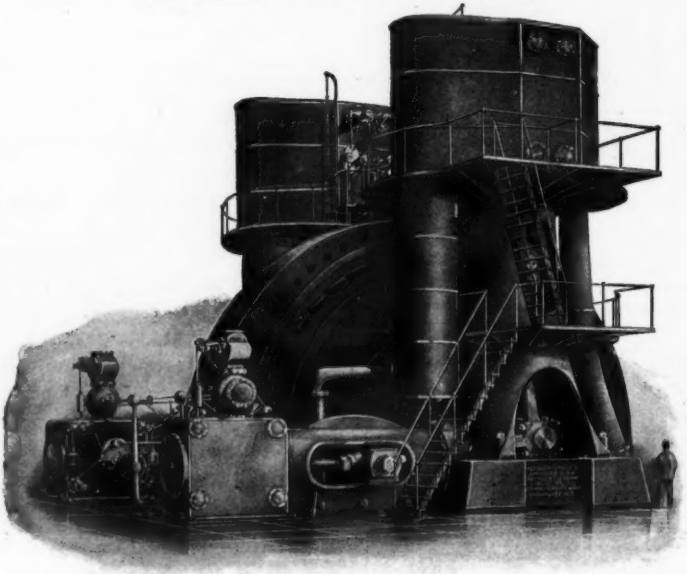

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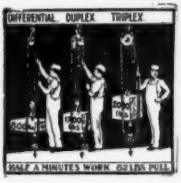

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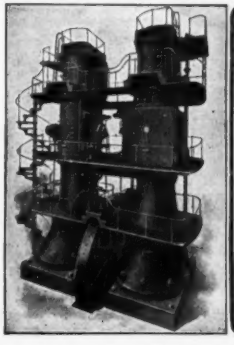

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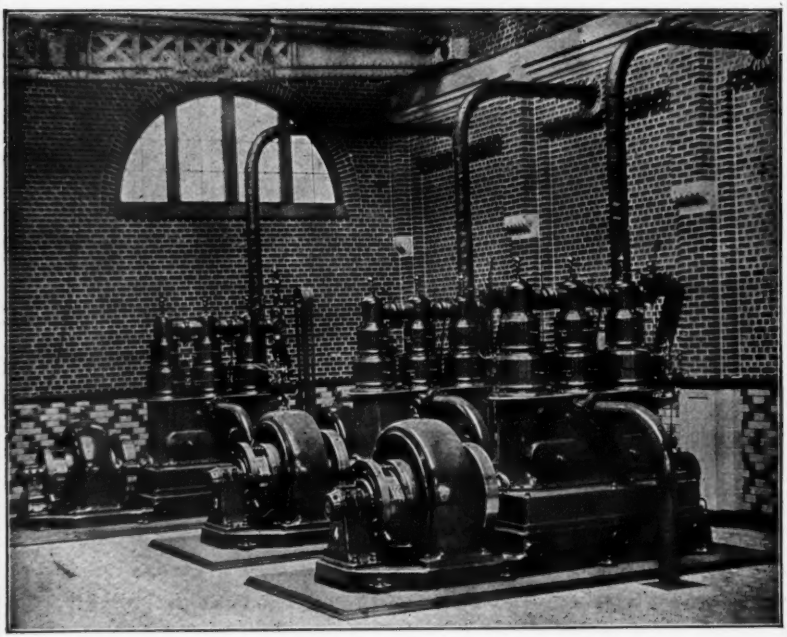

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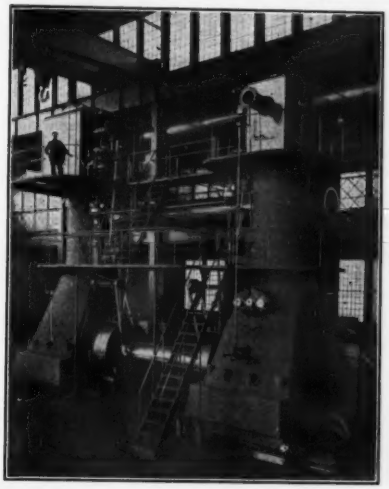

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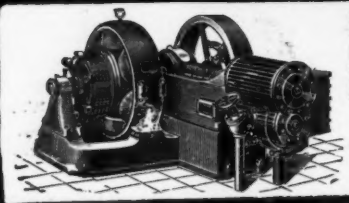

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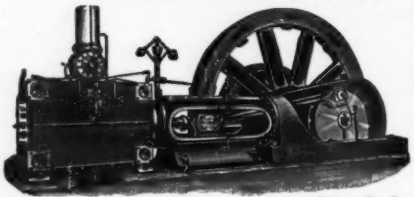

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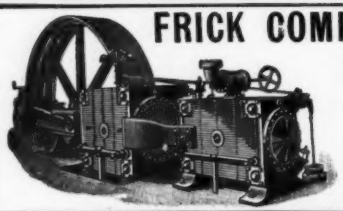

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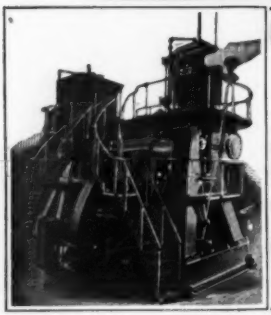

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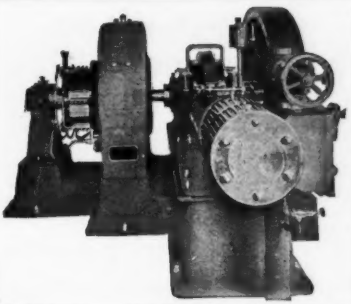

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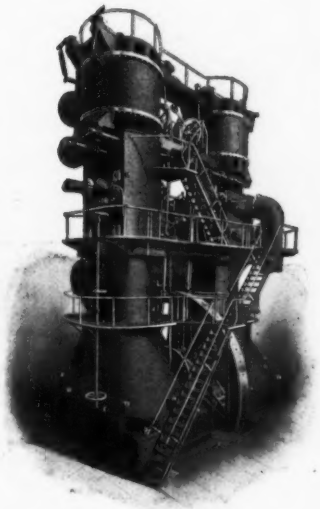

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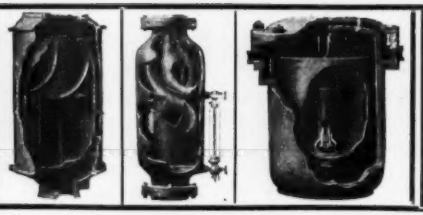

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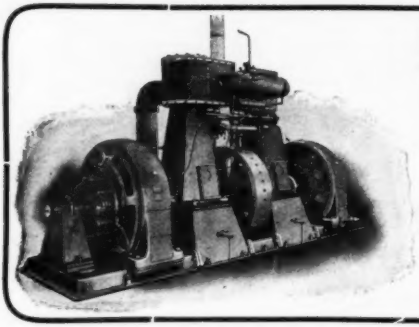

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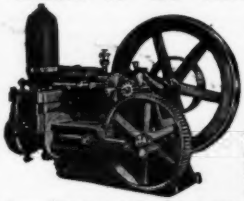

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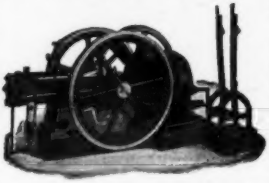

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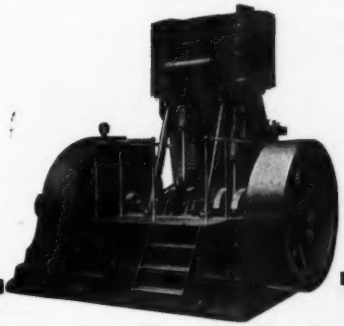

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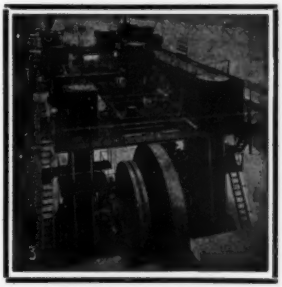

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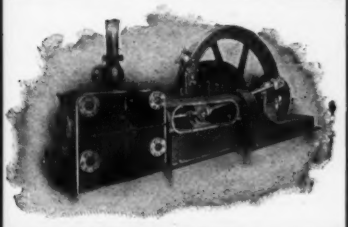

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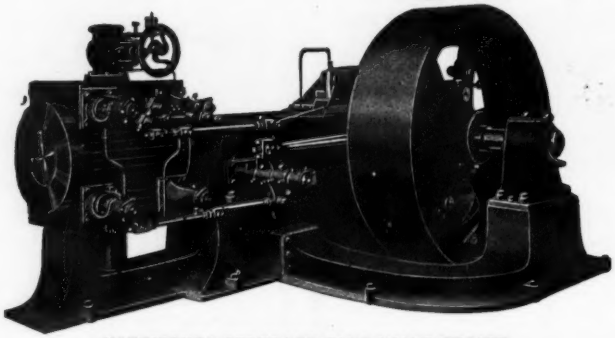

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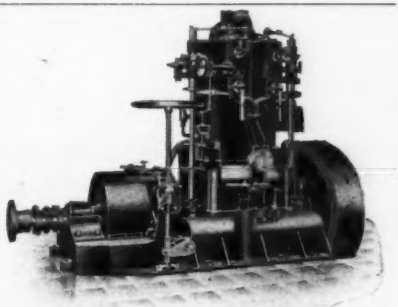

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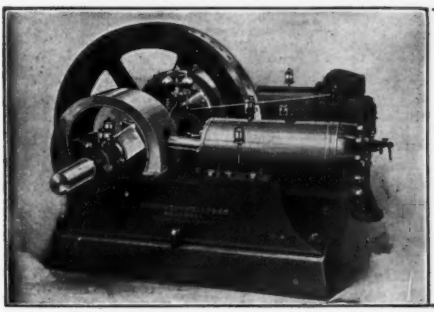

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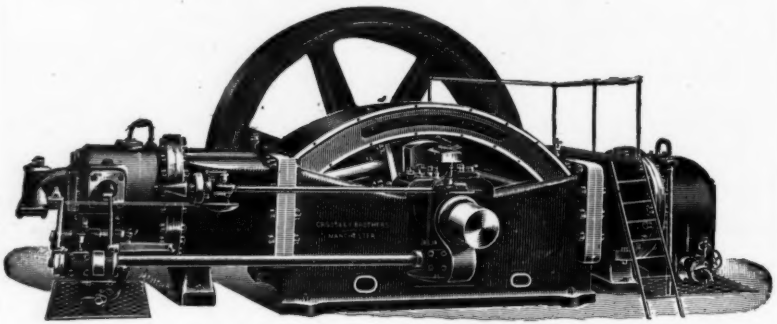

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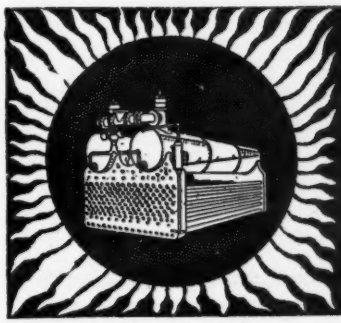

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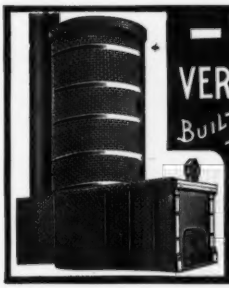

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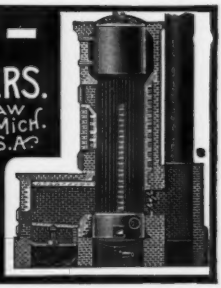

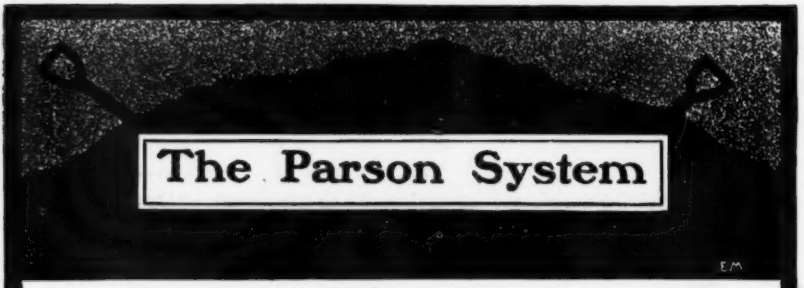

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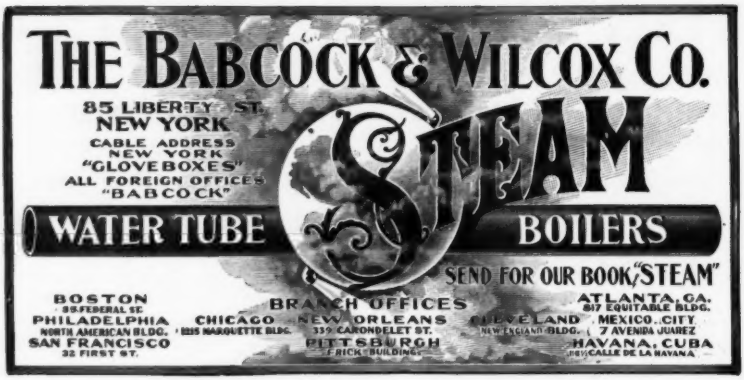

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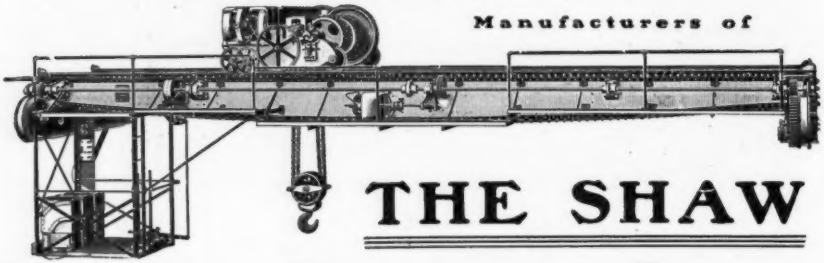

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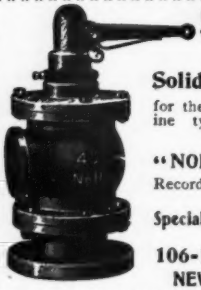

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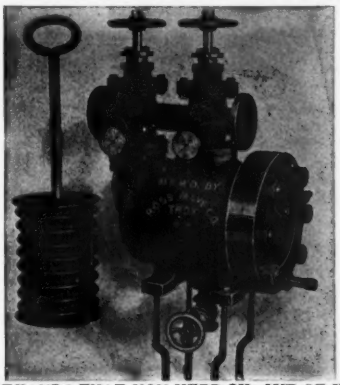

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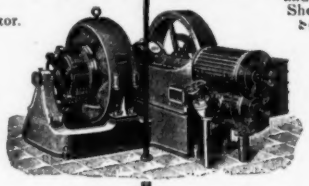

Fig. "L." Horizontal Cast Head and Large Steel Shell Receiver Separators.

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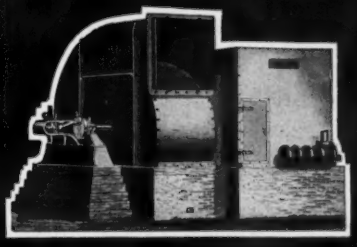

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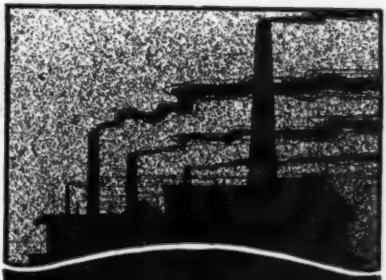

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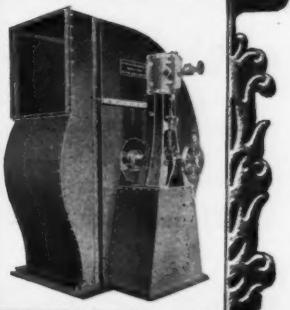

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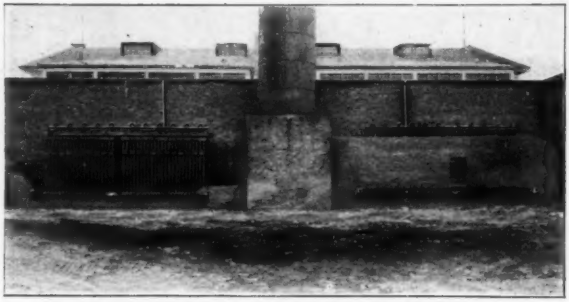

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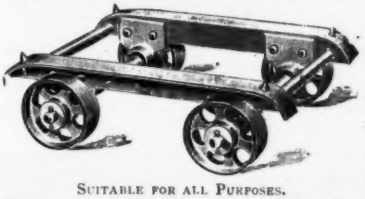

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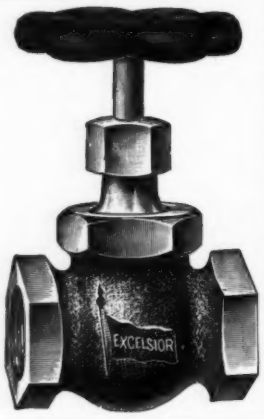

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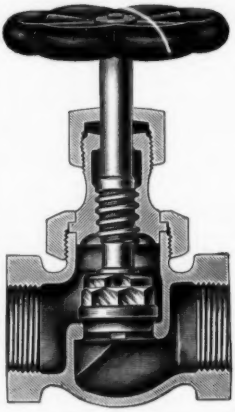

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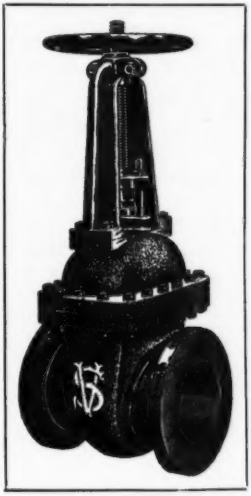

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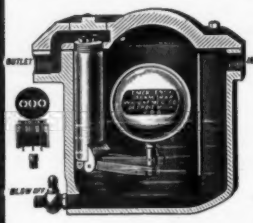

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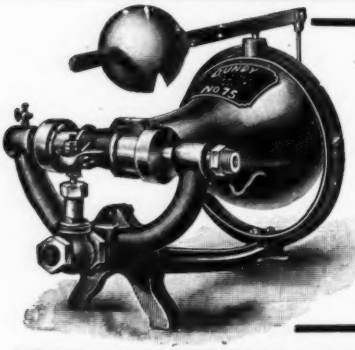

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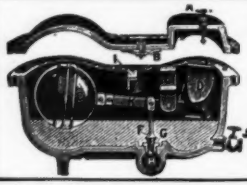

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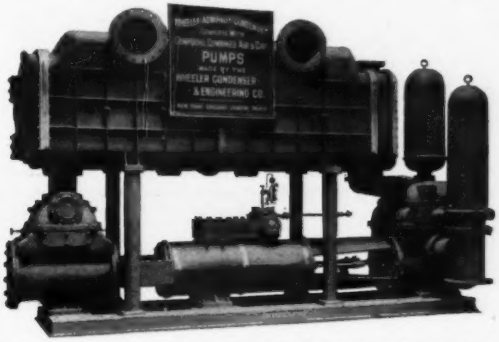

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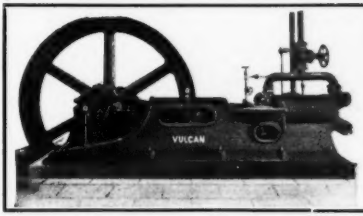

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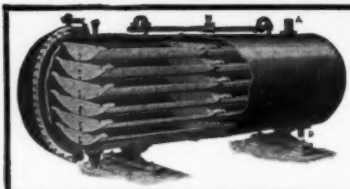

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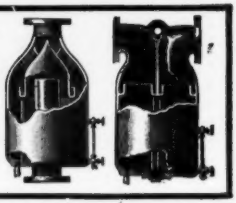

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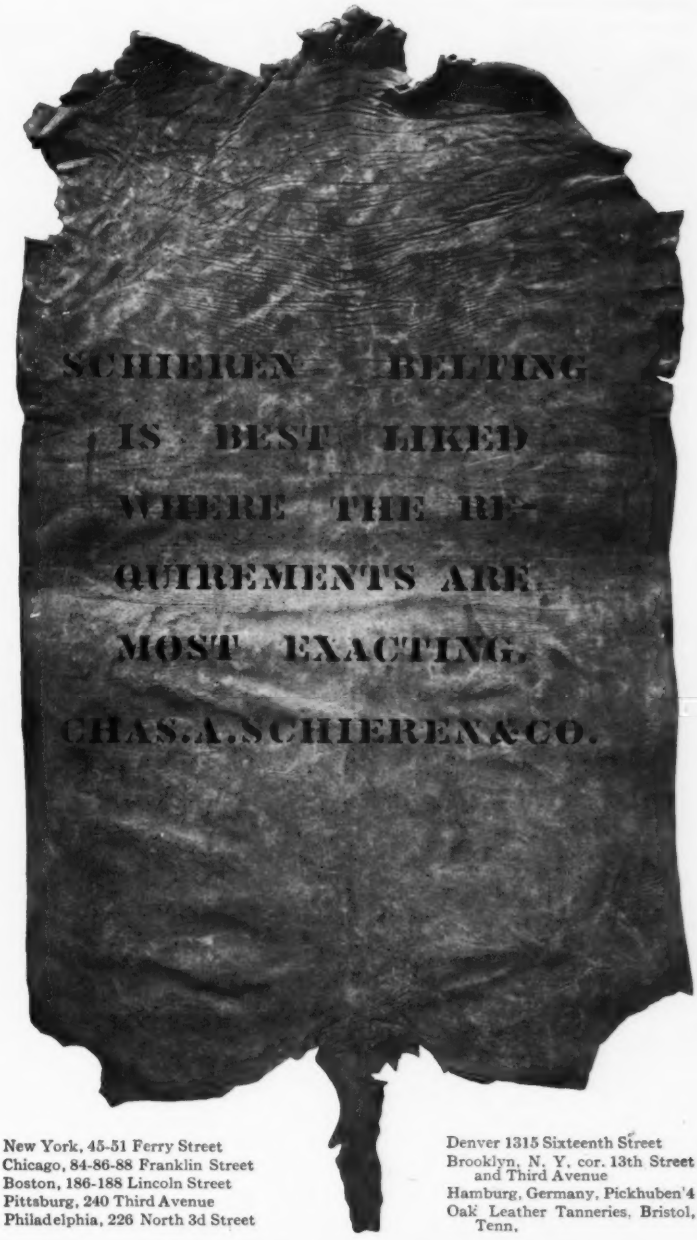

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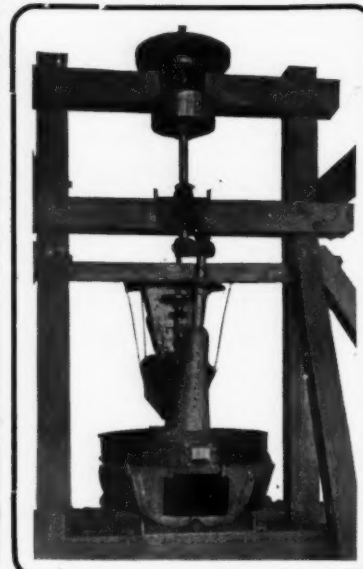

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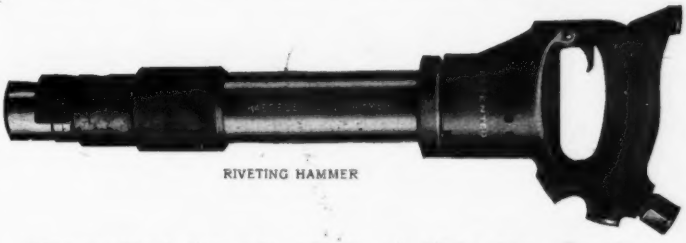

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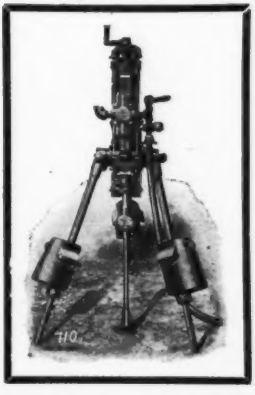

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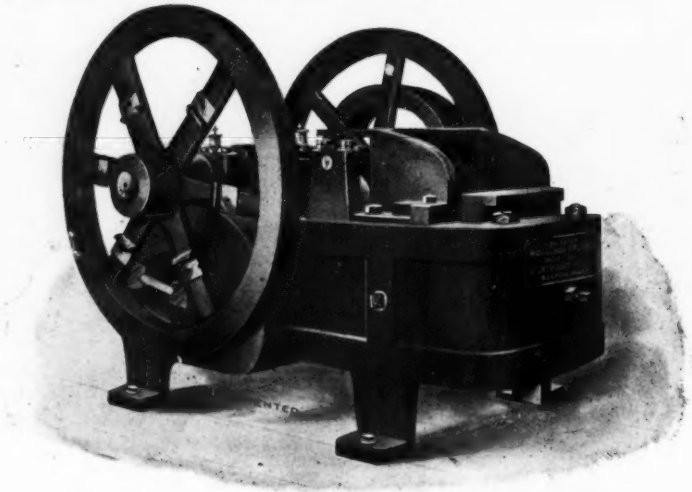

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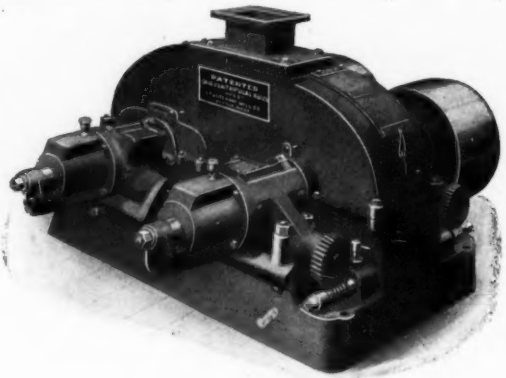

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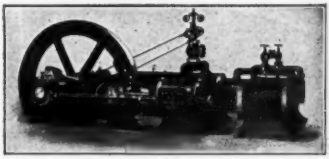

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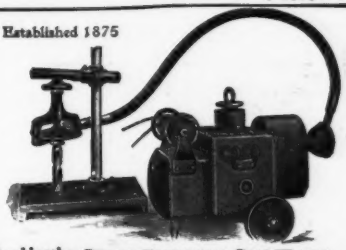

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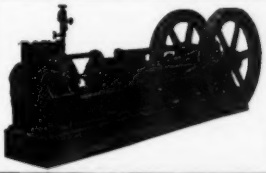

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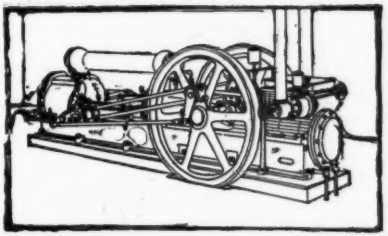

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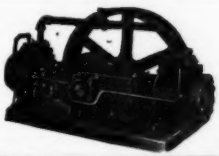

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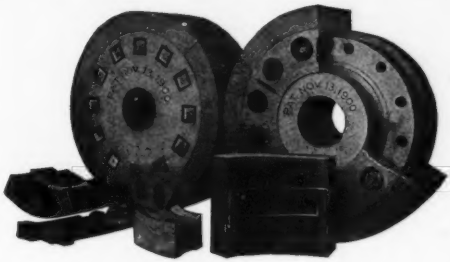

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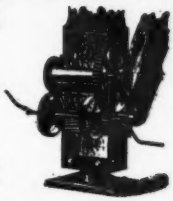

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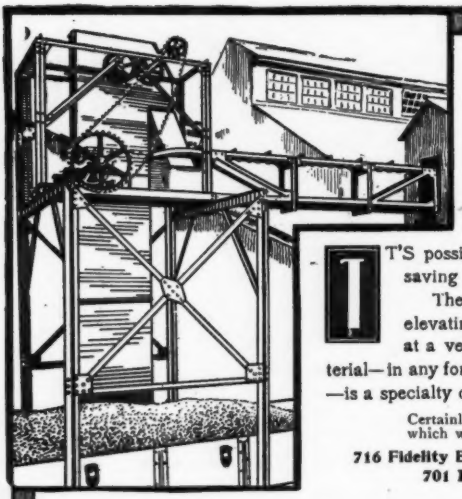

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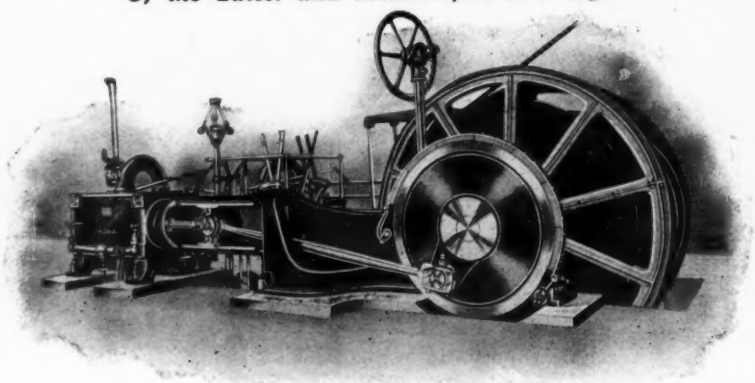

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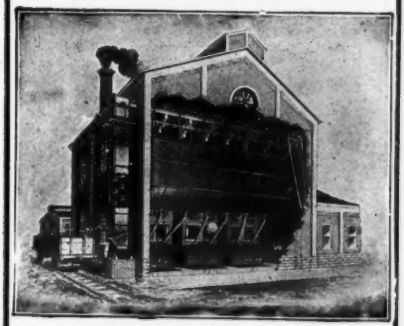

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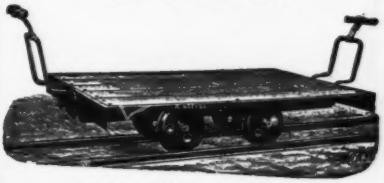

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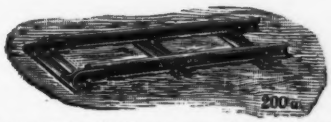

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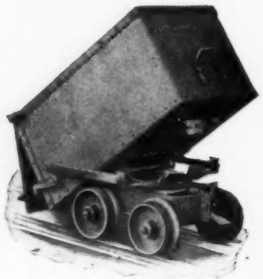

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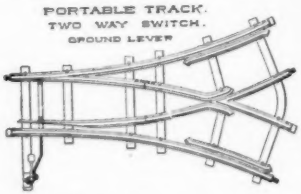

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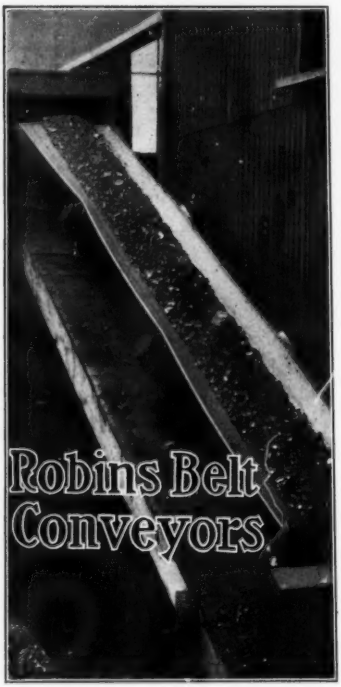

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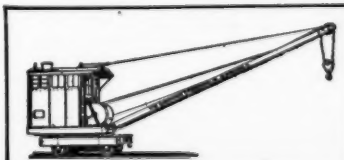

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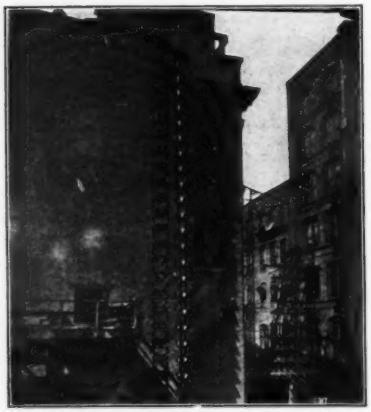

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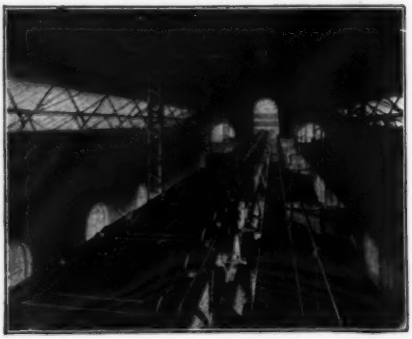

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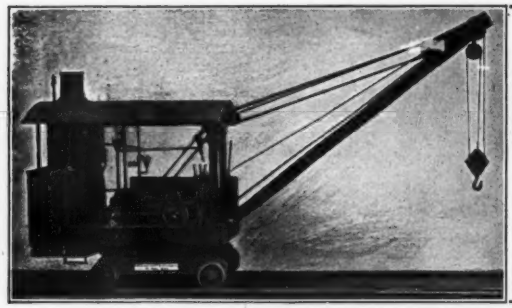

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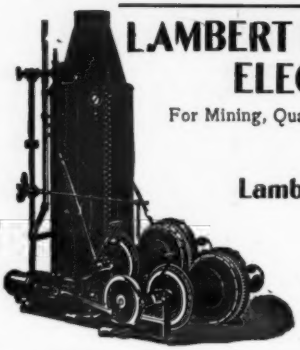

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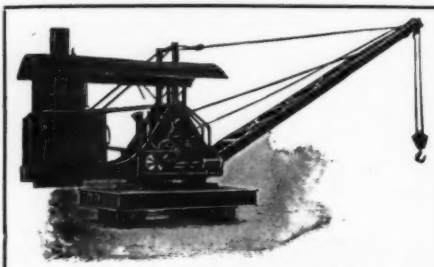

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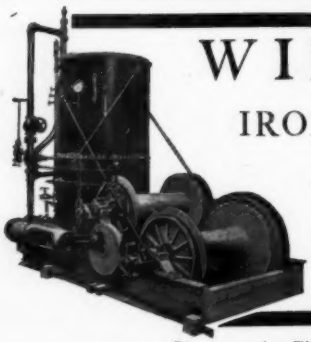

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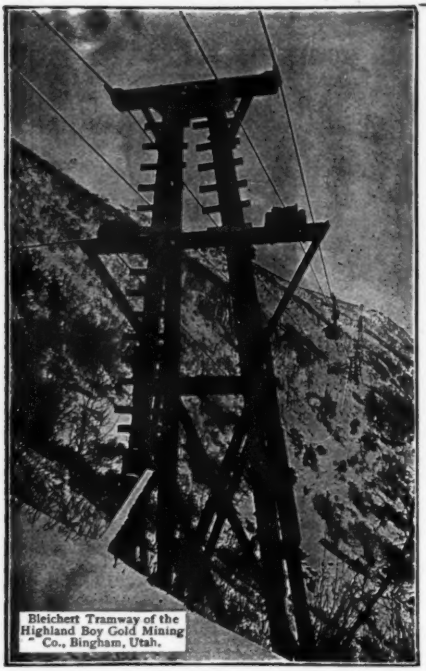

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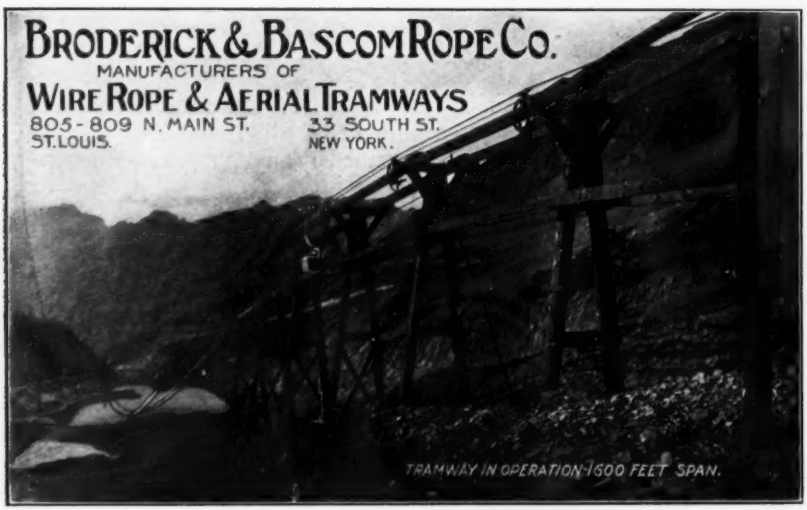
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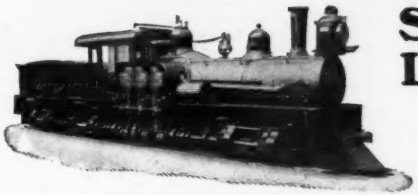

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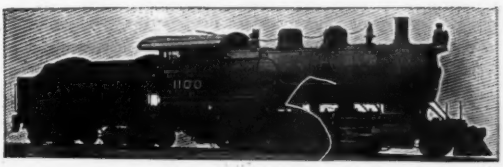

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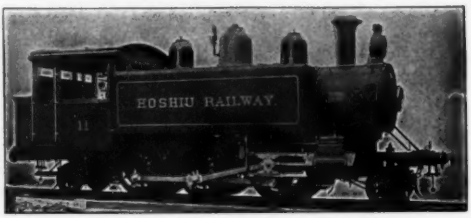

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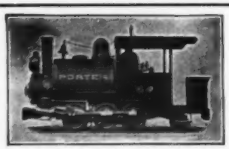

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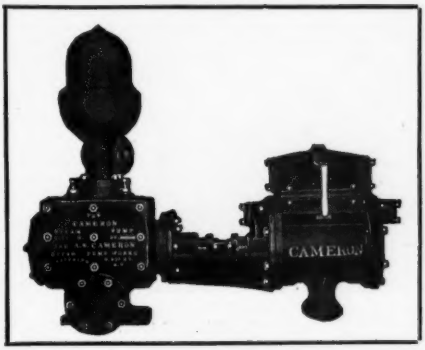

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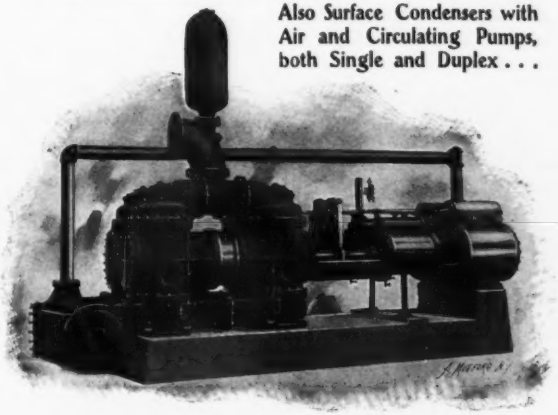

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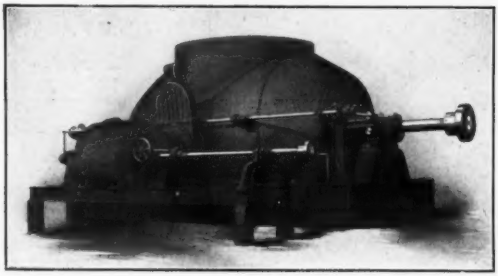

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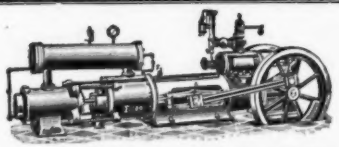

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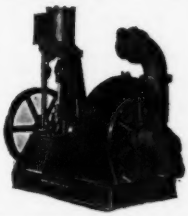

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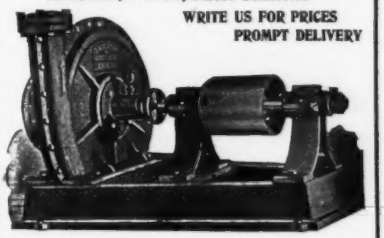

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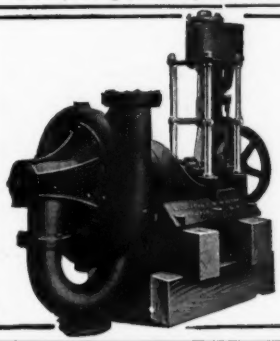

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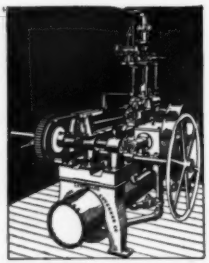

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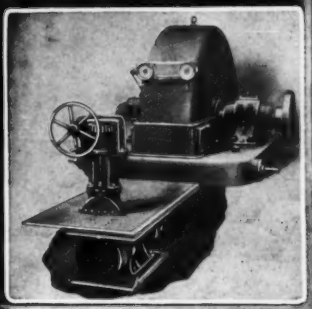

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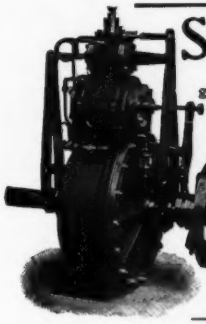

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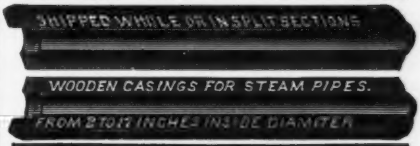

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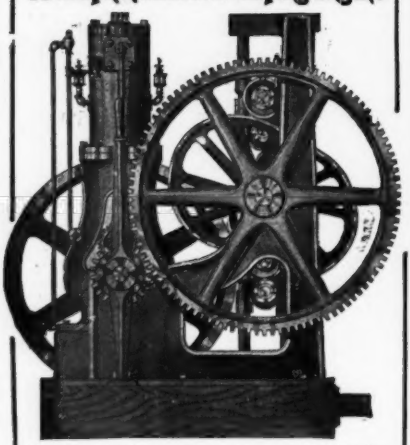

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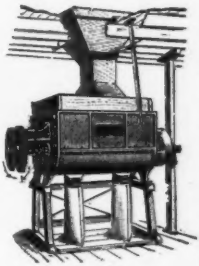

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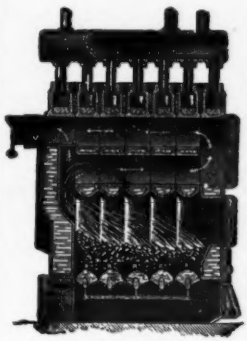

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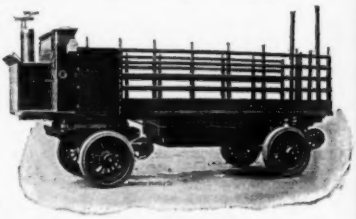

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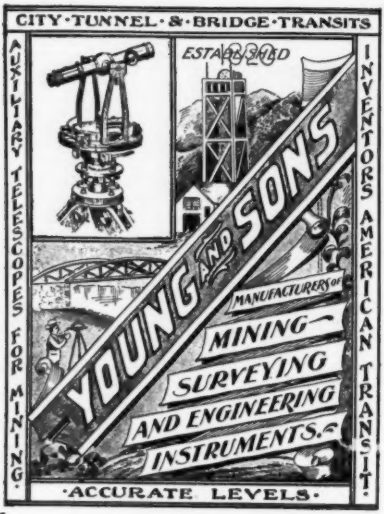

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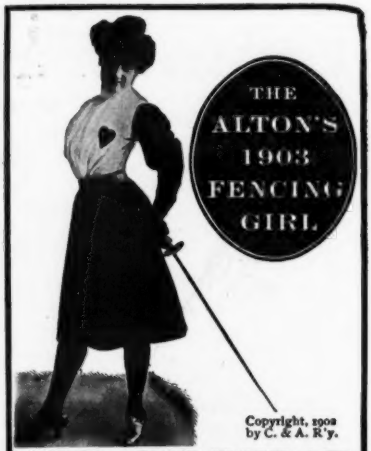

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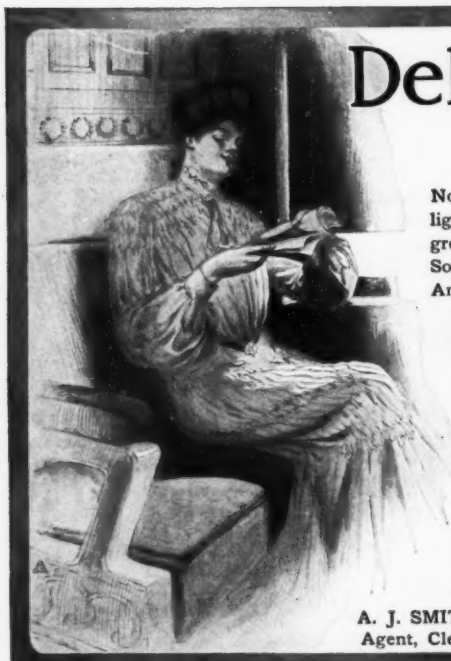

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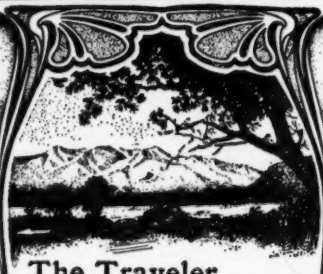

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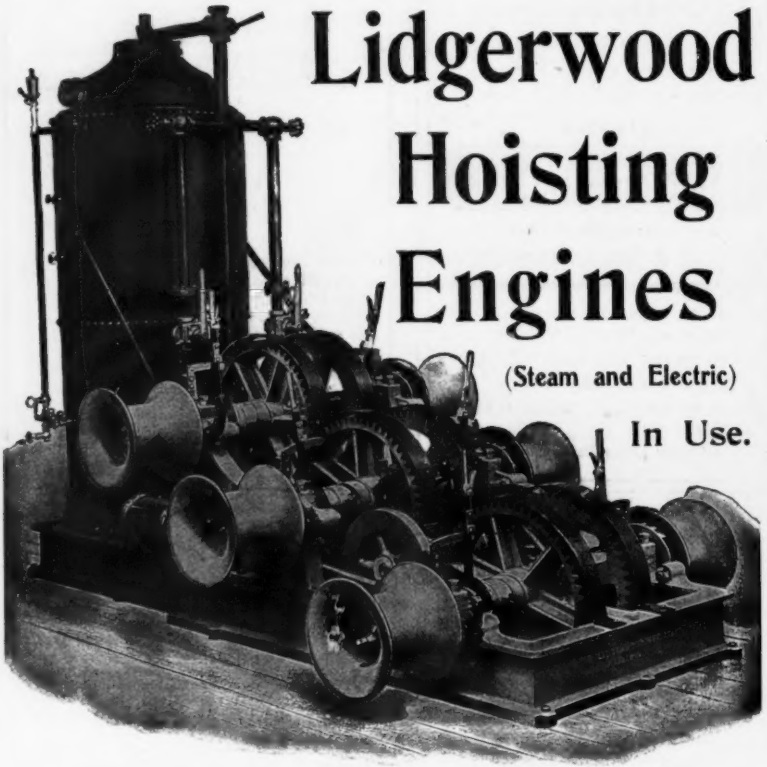

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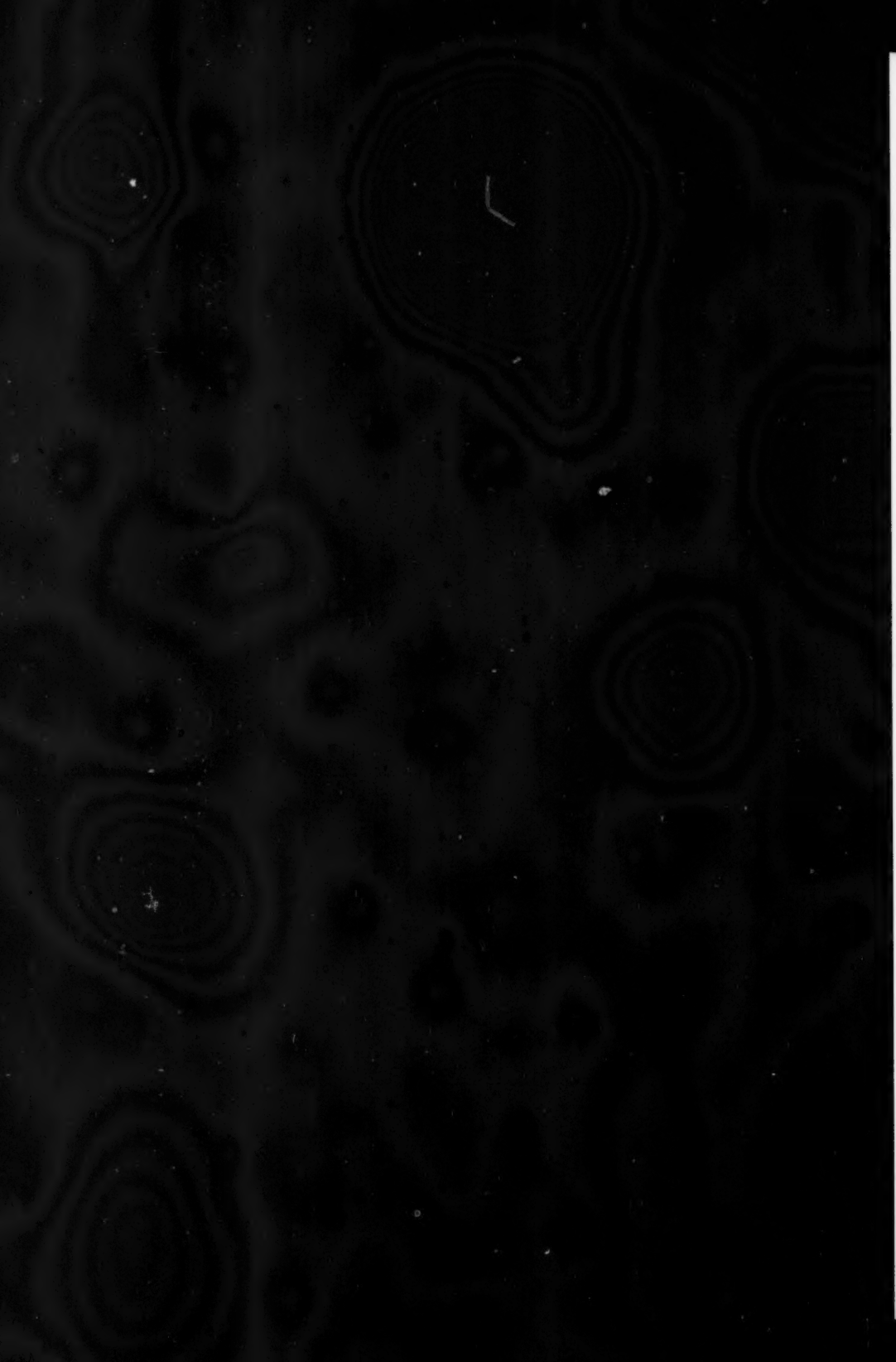

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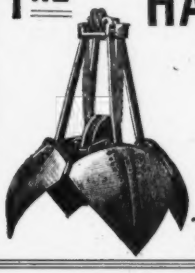

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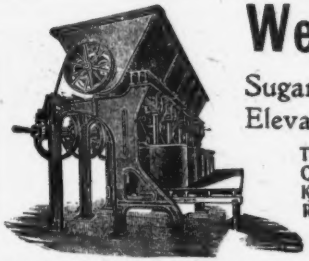

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